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A Case Study of Hazardous Wastes in Class I Landfills

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A CASE STUDY OF HAZARDOUS WASTES IN CLASS I LANDFILLS

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DISCLAIMER

FOREWORD

The Environmental Protection Agency was created because of increasing public and governmental concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research, a most vital communications link between the researcher and the user community.

The study reported herein documents the average concentration, estimated daily deposition, and partitioning of 17 metal species in hazardous wastes discharged to 5 Class I landfill sites in the greater Los Angeles, California area.

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ABSTRACT

This study documents the average concentration, estimated daily deposition, and partitioning of 17 metal species in hazardous wastes discharges to five Class I landfill sites in the greater Los Angeles area. These sites received an estimated combined daily volume of 2.3 X 10^6 l/day of hazardous wastes. A total of 320 samples were collected and consolidated into 99 samples representative of 17 industrial types. The data were summarized for six general industrial groups.

Using the average concentration of metal species and the approximate daily volume flow, the mass deposition rate can be determined for selected species at a site of interest. From this projection for the five sites combined, the metal species may be ranked according to their estimated total daily deposition: Na>Fe>Ca>Zn>K>Mg>Cu>Cr>Ni>Pb>Ba>Mn>V>Cd>As>Be>Ag.

Approximately 50% of the total volume of hazardous wastes sampled was generated by the petroleum industry. About 35% of the volume was equally divided between the chemical and industrial cleaning industries. The metal, food, and misc./unknown industries each contributed less than 10% of the total volume. The data indicate that the highest average daily mass deposition of metal species is generated by the following industries:

Petroleum	Ag, Be, Ca, Cd, K, Mg
Chemical	As, Na
Industrial Cleaning	Pb
Metal	Cr, Zn
Misc./Unknown	Ba, Cu, Fe, Mn, Ni

Approximately 70% of the total volume was in the aqueous phase and 8% consisted of an organic liquid phase. The weight percent of 17 metal species in the soluble phase ranged from less than 10% to a maximum of 90%. The volume flow and concentration of soluble toxic metals pose a potential water quality problem. Physical and chemical changes in the soil may significantly affect the vertical and lateral migration of toxic metal species. It is recommended that further studies on the intetactions of hazardous wastes and different types of soils and the resulting effect on leachate formation and migration of toxic metal species be conducted.

The report was submitted in fulfillment of Research Grant R 803813 by University of Southern California under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period August 1, 1975 to July 31, 1975, to July 31, 1976, and work was completed August 1977.

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SECTION 1

INTRODUCTION

OVERVIEW

The introduction of new and exotic materials into the environment has been occurring at an increasing rapid rate.[1,2] Every year more than 500 new chemicals and chemical compounds are introduced into industry along with countless operational innovations. Little is known about the environment and health aspects effects of many of these compounds, individually or in combination.[1] There is a necessity for identifying and cataloguing the industrial process and specific substances generated by these industrial processes.

Hazardous waste includes any waste or combination of wastes that poses a substantial present or potential threat to human health or living organisms because such wastes are lethal, nondegradable, or persistent in nature; may be biologically magnified; or may otherwise cause or tend to cause detrimental cumulative effect.[3] Hazardous wastes include, but are not limited to, toxic, biological, radioactive, flammable, and explosive by-products.

In recent years, more restrictive air and water pollution controls, including ocean dumping restrictions, are increasing the pressure for hazardous waste disposal to the land.[4] At least 10 million tons of non-radioactive hazardous wastes are generated per year, with a rate of increase estimated to be 5% to 10% annually.[5] By weight about 40% of these wastes are inorganic material and 60% are organic; about 90% occur as liquid or semiliquid. Over 70% of hazardous wastes are generated in the mid-Atlantic, Great Lakes, and Gulf Coast areas of the United States.[6]

Listings of various major industries by Standard Industrial Classification and the expected hazardous wastes for each industry have been made.[1] Detailed information on various constituents found in industrial hazardous wastes is also available in the literature.[1,6-8] At present, the most common methods of disposing of hazardous wastes is disposal on land, injection in deep wells, and discharge in the ocean. Sometimes explosives are detonated and/or burned in the open, and some organic chemicals, biological wastes, and flammable materials are incinerated. Each of these commonly-used disposal methods is a potential threat to public health and the environment.[9] The primary findings of EPA's 1973 Report to Congress on Hazardous Waste Disposal, which was mandated by Section 212 of the Solid Waste Disposal Act as amended, are that current hazardous waste management practices are generally unacceptable, and that public health and welfare are unnecessarily threatened by the uncontrollable discharge of such waste materials into the environment.[10] The Clean Air Act (as amended), the Federal Water Pollution Control Act (as amended), and the Marine Protection, Research, and Sanctuaries Act (as amended), are curtailing the discharge of hazardous pollutants into the Nation's air and water.[11-13] Increasing volumes of sludges, slurries, and concentrated liquids will therefore find their way to land disposal sites. This problem is manifested in potential groundwater contamination by leachate from landfills and surface water contamination via runoff.

The Atomic Energy Act of 1954, as amended (P.L. 703), and the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (P.L. 92-516) provide some mechanisms for control of disposal of radioactive and pesticide-containing wastes.[14-15] Other hazardous waste treatment, storage, and disposal activities have been essentially unregulated at the Federal level.

On September 27, 1976, Congress amended the Solid Waste Disposal Act (42 U.S.C. 3251).[16] The overall objectives of this act are: (1) Regulate the treatment, storage, transportation, and disposal of hazardous wastes which have adverse effects on health and the environment and (2) Provide for the promulgation of guidelines for solid waste collection, transport, separation, recover, and disposal practices and systems.

THE PROBLEM

Sanitary landfilling has been developed over a number of years as a means of disposing of various types of waste material. Many hazardous waste are disposed of at these sites even though many conventional landfillsites are not designed for the purpose of handling hazardous wastes. Due to the lack of effective controls, many hazardous wastes are also being disposed of in municipal landfill sites without special precautions.[17]

The problems associated with improper land disposal of hazardous wastes unlike the problems of air and water pollution have not been widely recognized by the public. In addition, the problem of hazardous waste disposal becomes even more significant as the progressive implementation of air and water pollution control programs, ocean dumping bans, and cancellation of pesticide registrations results in increased tonnage of land-disposed wastes with potentially adverse impact on public health and the environment.[18]

Groundwater or infiltrating surface water moving through solid wastes can produce a leachate containing dissolved matter, finely suspended particulates and microbial waste products. Leachate may leave the landfill as a spring of surface water or percolate through the soil and rock underlying the landfill. In either case, if leachate from a landfill is intermittently or continuously in contact with groundwater or surface water sources, the water can become polluted and unfit, for domestic or irrigational use.[19]

Uncertainty exists as to the long-term effectiveness of hydrogeologic isolation of a landfill in preventing aquifer degradation. This doubt stems from a lack of knowledge about the "life span" of the refuse in terms of leachate-generation capabilities.[16]

Contaminants carried by leachate are dependent upon the composition of the water and the physical, chemical, biological activities occurring within the landfill. Chemical analyses of leachate at landfill sites have shown a wide range of components.[20-23] There remains much to learn about the movement of hazardous wastes in the land environment. Laboratory-scale (soil column) investigations of transport mechanisms of specific hazardous wastes have been undertaken by the Municipal Environmental Research Laboratory, USEPA. This work has been designed to prove that potentially dangerous leachates can and do result from conventional sanitary landfilling of individual hazardous wastes. The resulting reports will include characteristics of the wastes and soils used, other pertinent experimental conditions, the data obtained including transmission rates and attenuation coefficients, and analysis of the potential environmental impact in the real world. The latter will include an analysis of the potential transportation rate through various soils under given rainfall conditions.[17]

If concentrations of hazardous wastes are high in the leachate from a landfill, attenuation capacity may be reached relatively quickly. Leachate treatment may be more complex than conventional water and wastewater treatment due to the wide variety of waste types and constituents. Land disposal of hazardous wastes normally requires a greater degree of planning and sophistication in design and operation at a given site than would normally be necessary with municipal refuse. The conventional landfill might be used, however, in those instances where the wastes contain a hazardous substance but in a form which is not particularly hazardous, i.e., insoluble salts, or in a concentration so low as to be innocuous. Certain other wastes should probably never be land disposed in the conventional landfill area, because of extreme hazards posed by the migration of even small quantities of toxicants.

Hazardous waste legislation has been enacted in several States;* Oregon, California, New York, and Minnesota are examples. In most cases, the disposal of the majority of hazardous wastes generated in the United States is not regulated by the State or Federal government. Of those few States with some type of hazardous waste controls, less than half have acceptable treatment/disposal facilities within their boundaries. Due to the generally limited scope of Federal, State, and local solid waste and land protection legislation, regulation, and enforcement, there has been little pressure applied to generators of hazardous residues to require disposal by environmental acceptable methods.[17]

The lack of reliable information has generated many concerns over the practice of confined landfill disposal of hazardous wastes. This report documents the concentrations and estimated mass deposition rates of 17 metal species in hazardous wastes discharged into five California Class I landfills. The results obtained in this study together with available data from USEPA soil attenuation and particulate leaching investigations may prove useful in assessing the pollution potential of hazardous waste disposal under less restrictive conditions, e.g., municipal refuse (Class II) landfills.

* Most notable around them are California, Minnesota, Texas, New Jersey, and Illinois. Several other states are in the legislative process in an attempt to conform to PL94-580

SECTION 2

CONCLUSIONS

The following conclusions have been drawn from this study on the distribution and mass deposition of selected metal species in hazardous wastes generated by diverse industry types.

1. The average concentrations, estimated average daily inputs, and the partitioning of metal species (soluble and solid phase) varied over a wide range for the five selected Class I landfill sites. These variations are not unexpected when considering the limited number of samples analyzed (99), the different industry types represented by these samples (17), and the range of estimated volume flow for the five sites (1.1×10^5 l/day).

2. The data collected for individual sites, together with the estimated daily volume input, permit the approximation of mass deposition rates of selected metal species at a site of interest.

Knowing the approximate daily volume flow, volume percent from industry types, and the average concentration of metal species, the mass deposition rate of individual metals can be determined. Calculations based on the available data indicate that the highest average daily deposition of metal species is contributed by the following industry types:

Petroleum	Ag, Be, Ca, Cd, K, Mg
Chemical	As, Na
Industrial Cleaning	Pb
Metal	Cr, Zn
Misc./Unknown	Ba, Cu, Fe, Mn, Ni, V

3. The results indicate that copper, chromium, and zinc wastes present the greatest potential threat to groundwater and surface water supplies in consideration of: (1) total mass deposition, (2) weight percent in the soluble phase (42% to 86%) and (3) maximum concentration levels (14,000 - 20,000 mg/l).

4. Approximately 8% of the total volume input consisted of liquid organic wastes; 16% of the organic phase had boiling points less than 95°C and flash points as low as 17°C. The mixing of volatile organic wastes, particularly those with low flash points, with incompatible wastes at a disposal facility can produce dangerous situations through fires and explosions.

5. The combined results for the five Class I sites are considered an

approximate representation of the hazardous waste stream generated in the greater Los Angeles area. The unknown effects of certain variables prevent a more accurate determination, e.g., (1) the effects of seasonal types of disposal are not known (samples were collected during five days over a two-week period), (2) process changes and varied production rates by large volume generators such as the petroleum and chemical industry, (3) limited number of samples, (4) the total volume sampled ($2.5x10^6$ l) is only slightly larger than the estimated daily volume input of $2.3x 10^6$ l, and (5) accuracy of the estimated daily volume input is not known.

6. Food industry manifests encountered during this study are of questionable accuracy. High concentrations of As, Ba, Be, Cd, Cr, Cu, Ni, Pb, V, and Zn were detected in one or more of six food industry waste streams. The concentration levels are incompatible with the waste types listed on the manifests, e.g., dishwater, steam-rack cleaning, cannery wastes, and bakery wastes. It is suspected that other industrial wastes were picked up by the waste hauler and were not recorded on the food industry manifests. It is not known whether this was a deliberate subterfuge or simply indifference or carelessness.

7. The manifest system required by the recently amended Solid Waste Disposal Act should provide, if enforced, adequate monitoring and control of hazardous wastes. However, this will require a Federal commitment of money to support the manifest development and manpower to enforce the developed product.

8. The volume flow, concentration, and mass deposition rate of the toxic metal species determined in this study should prove useful in the preliminary selection of required treatment processes and facilities for hazardous wastes generated by various industrial activities. The distribution of metal species in the soluble and solid phases of the hazardous waste is also significant because it is anticipated that the treatment and disposal of liquid and solid wastes will be processed separately.

SECTION 3

EXPERIMENTAL

This study was carried out by a cooperative program between the University of Southern California and the California State Department of Health. Liquid wastes were collected at 5 major Class I landfill sites in the Los Angeles basin: B.K.K. in West Covina; Pacific Ocean Disposal (P.O.D.) in Wilmington; Operating Industries (O.I.) in Monterey Park, Calabasas (C.B.); and Palos Verdes (P.V.) B.K.K., P.O.D., and O.I. sites are operated by the Los Angeles County Sanitation District. A hydrogeologic description of the five sites is presented in Appendix B. Assessment of waste hazards, environmental impacts and compatibilities must be primarily based on a sound knowledge of waste chemical composition. Such knowledge requires a simple, rapid and representative sampling method along with accurate analytical techniques.

The parameters listed below must be considered in hazardous waste sampling programs.

Phase Complexity: Hazardous wastes appear as all phases: solid, aqueous, and organic liquid. Very often the waste is a complex mixture of all of these phases. Sampling techniques must be able to give representative fractions of all phases.

Access to Waste: Hazardous wastes are contained in ponds, vacuum trucks, barrels, etc. Sampling must be adaptable to all of these.

Chemical Reactivity: Many wastes are highly corrosive or strong oxidizers. Many wastes, although not particularly reactive are, because of their physical nature, very hard on equipment. These features place severe demands on equipment design.

Safety: The relatively undefined nature of most waste creates a significant safety problem to sampling personnel. Rather extensive precautions must be taken.

Sample Containment and Preservation: The containment and preservation of corrosive, highly toxic, or highly volotile samples in the field present significant problems.

SAMPLING TEAMS

Each sampling team consisted of three persons. Two functioned as primary sample collectors, and one as record keeper. Prior to the sampling program, all personnel were thoroughly briefed on procedures and safety precautions. This was very important, for several of the personnel had little or no experience in hazardous waste sampling. However, everyone involved directly in sampling activities in this program had some experience and background in either chemistry and/or industrial hygiene. The teams appeared at disposal sites on an unannounced basis and remained at each site from one-half to a full working day. Over a period of two weeks, the teams circulated among all the Class I disposal sites in the Los Angeles Basin according to the schedule shown in Table 12. The purpose of this movement was to avoid major perturbations in normal waste traffic patterns. An effort was made not to establish a pattern of sampling at any one disposal site. These precautions were necessary because it has been the experience of the California Department of Health that the presence of sampling personnel at a disposal site significantly affects waste volumes. Information haulers and disposal sites. This factor can lead to a total unrepresentative sample of waste input. Based on a review of manifests over a one year period of time, it is estimated that samples collected during the study, represent 90% of the waste types received at these sites over a one year period. The remaining 10%, mainly seasonal types of disposal, could not be sampled due to the short duration of the program.

SAMPLING EQUIPMENT INVENTORY

Table A-2 lists the complement of sampling equipment which each team carried. This equipment list was constructed to supply needs for all the necessary functions of the sampling team. It was considered important to have each team self-contained and independent of the disposal site facilities. These necessary functions are:

a. Sampling acquisition
b. Equipment cleaning
c. Sample storage
d. Safety protection
e. Record keeping

A conventional 3/4-ton pickup truck with a utility side body was used as the sampling vehicle. The utility body provided adequate storage for all sampling equipment. This same basic vehicle was later adapted, with some modifications into the field surveillance vehicle currently used by the California Department of Health.

SAMPLING PROCEDURES

The object of the sampling program was to obtain representative samples of all liquid, sludge, and solid wastes delivered to a disposal site during the time when sampling personnel are present. This presents some operational problems when high volume industrial waste sites are involved. During a typical day, 40-50 trucks deliver waste to the site. The deliveries are not evenly spaced and several trucks may arrive simultaneously. Sampling procedures must be efficient to prevent excessive delay of the trucks. Such delay usually causes severe complaints by the disposal site management and by truckers. Efficient procedures are additionally important because it is during these periods of high activity that accidents have the greatest probability of occurring.

The stepwise procedures for sampling are given below.

1. Intercept Waste Trucks: At most industrial waste sites in California, incoming trucks must stop at a tollgate to submit a waste manifest and to pay disposal charges. At this time, sampling personnel approach the truck driver and request a copy of the manifest. The manifest is checked for declared waste composition, physical state of the waste, and possible safety hazards. The manifest is given to the recorder and appropriate information is transferred to the waste sampling form (Appendix C). The truck operator is requested to open the center inspection hatch of the truck.

2. Sample acquisition: Sampling personnel put on all necessary personal safety equipment, which includes full protective boots, respirators with general purpose filter cartridges, hard hat and full face shield. The person sampling must climb onto the truck and walk along narrow catwalks; therefore, safety equipment should not be too cumbersome. When the primary sampling person is positioned at the opened tank hatch, the backup person hands him the Coliwasa sampling equipment (Figure 1). This backup person then stands ready with sample container and to aid in any problems.

The Coliwasa waste sampler is relatively simple, consisting of a hollow PVC tube, nominally 1 1/2" I.D., with a concentric PVC rod which is attached to a neoprene stopper. The sampler is lowered into a liquid or sludge waste to cut across a column of material. The sampler is then closed at the bottom, trapping a sample inside which is representative of all the layers and phases of the waste. Volume of sample taken is about 350 ml/foot of depth of sample. The waste samples are transferred directly from the sample tube to a one-liter polyethylene container.

Jars were sealed with plastic lids, numbered, and stored on the sampling truck for approximately 4 days before transfer to 4°C storage. Sample jars were used directly from manufacturers' cases without washing. During sampling, open jars were inverted to prevent contamination by trace metals in the atmosphere. An acidic blank prepared in a sampling jar showed no appreciable amounts of heavy metals.

A schematic diagram for sample collection, preparation, and analysis appears in Figure 2.

Using the sampling equipment available at the time of this study (Coliwasa Model A), certain problems were encountered in the transfer step. When the sample tube was withdrawn from the liquid waste truck, occasionally the sample retaining stopper at the bottom of the tube would dislodge and release the samples. If this occurred while the tube was still in the tank, the sample would simply discharge back into the tank. If, however, discharge occurred during the transfer from the tank truck to the area of the sample bottle, a possible accident could occur. This feature was a design flaw in the Coliwasa Model A, which is to be corrected in later models. The necessary improvement would be some type of positive locking mechanism to prevent accidental discharge of the waste. After the sample bottle is properly sealed and labeled, the sampling equipment must be cleansed in preparation for the next waste load. The entire process of sampling from stopping of the incoming

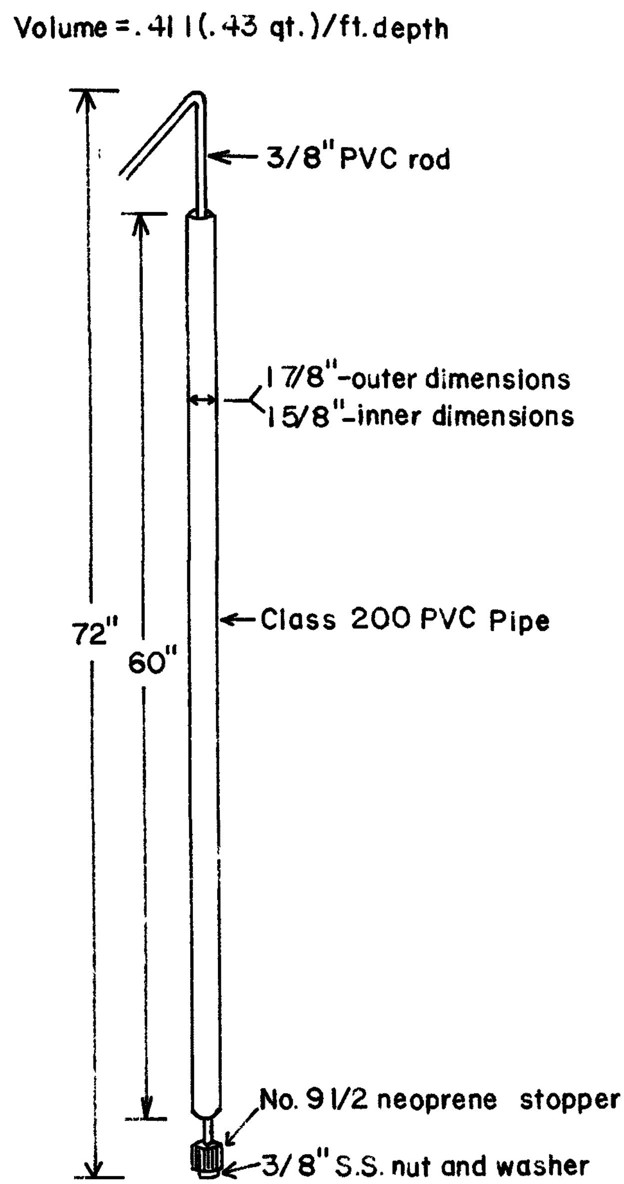

Figure 1. Composite liquid waste sampler (Coliwasa).

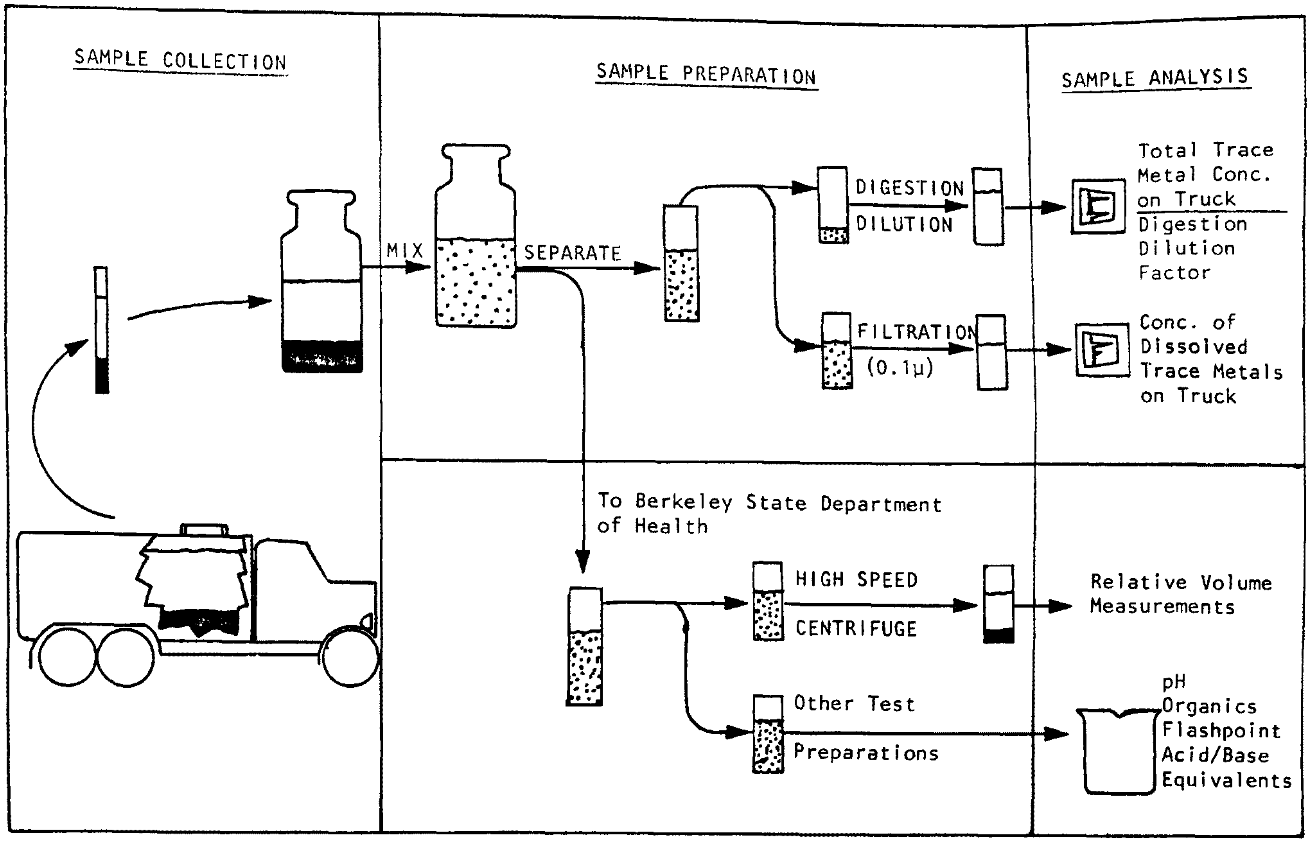

Figure 2. Schematic of sample handling.

truck to equipment cleanup takes approximately 5-6 minutes.

3. Equipment Cleaning: Sampling equipment cleaning is one of the more difficult and time consuming steps in the entire sampling program. Due to the wide variety of waste products which include heavy, viscous, tacky, odiferous, and generally obnoxious materials, cleaning of equipment becomes a challenge. The procedure used in this study involved just a rinse with a strong aqueous detergent and scrubbing with a long-handled bottle brush. This was followed by a rinse and scrub with trichloroethane followed by air drying. A 55-gallon "slop" barrel was used to catch all wash water and solvent, rags, and other discards. The barrel was properly disposed in the disposal site following the sampling period. It was the experience of this study that a Coliwasa tube had to be discarded after being used 5 or 6 times due to excessive contamination. Decontamination of these sampling tubes required too much time and excessive use of solvents. As a result, the sampling equipment must be at least semi-disposable. This required that it be easily fabricated from inexpensive materials. The Coliwasa described in this study meets these criteria.

ANALYTICAL METHODS

General Parameters

Solids content (total, soluble, insoluble), pH, acidity and alkalinity were measured in accordance with procedures described in Standard Methods, 14th Edition.[24] Mineral acidity and total alkalinity were determined by potentiometric titration to pH 4. Flash point was measured by a Tag open-cup tester in accordance with ASTM Standard Methods, D 1310-72.[25] Phase distribution (organic, aqueous, solid) was determined by centrifugation for 10 minutes at 12,000 RPM; the separated phases were removed and recorded as a weight percent. Volatile organics were determined by distillation of the organic phase at 95°C with a Kontes microsteam distillation unit.

Metal Species

Sample preparation for filtration and digestion included thorough washing of all labware which would come in contact with samples. The following washing procedure was used: Scrubbing with a brush using detergent and industrial water. Three rinses with deionized water. Soaked in 5% HNO_3 for 5 days. Rinsed with deionized water. Dried in low temperature oven. Stored in washed polyethylene bags.

Samples, collected as described above, were stored at 4°C in the original one-liter plastic containers. After one week, about one-third of each sample was poured into an identically labeled container and sent to the State Department of Health for analysis of organics and determination of percent liquid and solid volumes. Samples were returned to 4°C storage until aliquots were taken for filtration and digestion. Samples were kept at room temperature for approximately two days during this process. One aliquot was poured first through a #1 Whatman Filter and then passed through a 0.1 nm millipore filter into a sample bottle. Another aliquot (5 ml) was placed in a teflon beaker and digested with HNO_3, HF and $HClO_4$. The resulting liquid was centrifuged, poured into sample bottles, and diluted.

Sample Analysis

The partitioning of trace metals between those in the soluble phase and those associated with nonfilterable solids was attained by analyzing the filtrates (0.1 nm) and the acid digested total sample. Nonfilterable solids are then determined by subtracting dissolved trace metal concentrations from total concentrations.

Seventeen metal species were analyzed, including: Be, Na, Ag, Mg, K, Ca, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Cd, Ba, and Pb. All analyses were performed on a Perkin-Elmer Model 305B double beam atomic absorption spectrophotometer equipped with a HGA 2100 graphite furnace. Sodium and potassium were analyzed using emission flame photometry. The graphite furnace was employed in the analysis of As and Cd, low concentration toxic elements, and Be, V, and Ba which require special fuel (nitrous oxide-acetylene) when analyzed by flame methods. Levels of the other elements (Mg, Ca, Cr, Mn, Fe, Ni, Ca, Zn, Ag, and Pb) were determined by direct aspiration into an air-acetylene flame.

Apparatus

(A) A Perkin-Elmer Model 305B double beam spectrophotometer equipped with a HGA 2100 graphite furnace and deuterium arc background corrector.

(B) Perkin-Elmer Model 56 single pen recorder.

(C) Perkin-Elmer hollow cathode lamps (Be, Mg, Ca, V, Cr, Mn, Fe, Ni, Cu, Zn, Ag, Cd, Ba, Pb).

(D) Perkin-Elmer Electrodeless Discharge Lamp (for As) and power supply.

(E) Corning Mega-pure water distillation unit with Arrowhead Industrial water ion exchange bed.

Reagents

(A) Prepurified air

(B) Acetylene-standard commercial grade (for flame)

(C) Deionized distilled water

(D) Nitric acid, HNO_3, conc. ultra pure ultrex nitric acid

(E) Standard metal solutions

(F) Prepurified Ar gas (for HGA)

(G) Ni $(NO_3)_2$ for As

(H) Hydrogen sulfide

Procedure

Washing Procedures

Washing procedures were the same as those outlined for preparation of sample bottles for filtration and digestion.

Standard Solutions

Standard solutions were prepared in opaque polyethylene bottles. Several bottles were filled with concentrated ultra pure HNO_3, allowed to stand 14 days, and analyzed for metal contamination. None was detected. Bottles were prepared as outlined above. Appropriate amounts of stock 1000 ppm solutions of each element to be analyzed were injected into the prepared bottles using Eppendorf micro pipets with disposable tips. Concentrated ultra pure HNO_3 and deionized distilled water was added diluting to the appropriate volumes. These standards were checked with values of previously prepared standards (and found to agree).

Flame Atomizer Determination Method

This was the preferred method for determination of most elements because it is the fastest method capable of detecting the species in the ug/ml concentration range. A Perkin-Elmer Atomic Absorption Spectrophotometer Model 305B with flame atomizer and deuterium arc background corrector was used. Operating conditions are listed in Table A-3. The procedures were essentially those listed in the Perkin-Elmer publication "Analytic Methods for Atomic Absorption Spectrophotometer".[26] Emission parameters were also developed.

Some operating conditions were changed midway in the analysis of sample metrices. For example, an air-rich oxidizing flame increases sensitivity in the analysis of Mg, Mn, Fe, Ni, Cu, Zn, Ag, Pb, Na, and K. However, the matrices of some samples acted as fuels producing reducing flames which undoubtedly yielded low values for the affected elements in those samples.

The standard additions methods to eliminate matrix effects were not generally used because time limitations magnified the intrinsic properties of hazardous wastes which require special handling and preparation. The major matrix effect is expected to be the lowering of dissolved metal values for samples which were somewhat viscous and hence were aspirated at a slower rate than the standards. Precipitates which formed in some samples upon dilution probably had the same effect.

HGA Direct Injection Method

A Perkin-Elmer 2100 Heated Graphite Atomizer attached to a Perkin-Elmer Model 305B double beam spectrophotometer was used to determine Be, V, As, Cd, and Ba levels. Appropriate hollow cathode lamps were used except for As analysis, for which a discharge lamp (EDL) was employed.

Operating parameters for HGA analysis were those recommended in the 1973 Perkin-Elmer publication, "Standard Conditions for the HGA" with very slight modifications (see Table A-3). Prepurified argon gas was used in the continuous flow mode (normal) with gas flow greater than those recommended. The modification increased the linear concentration range with tolerable sensitivity losses. The desirability of extending the linear range is apparent upon examination of Table A-4 which shows the wide concentration ranges encountered in hazardous waste samples.

Sensitivities are generally much greater than those obtainable by flame atomization. Sensitivities are not uniform for each element. Changes in sample volume delivered into the HGA were injected. Sensitivities were probably less prominent than when using flame atomization. Other matrix effects, for example, the possible lowering of values by the presence of inorganic salts, was randomly checked by standard additions method in 10 samples.

SECTION 4

RESULTS AND DISCUSSION

A total of 320 waste samples were collected. Suplicate samples (those originating from the same source believed to be identical to previous samples) were identified and sorted so that one representative of each duplicate set would be analyzed. This operation reduced the number of samples for metal analyses to 99 for the five sites: B.K.K. (41), O.I. (40), P.V. (14), P.O.D. (3), and C.B. (1).

While the EPA is interested in obtaining information on the input of hazardous wastes into specific sites to be extrapolated to the national scale, the State of California is interested in studying the flow and mass deposit rate of metal species determined in this study, compared with other areas of the United States, will probably vary greatly depending on the nature and volume of regional industrialization.

The calculated mass deposit on rates are based on the total volume inputs estimated by the Class I site operators. These values are significantly larger than the hazardous waste volume flow rates estimated by the California State Department of Health based on extrapolated sample volumes (Table 1).

TABLE 1. VOLUME INPUT--CLASS I SITES, 1 X 10^5/DAY

Site	Site Operator	Calif. Dept. of Health	% of Site Operator Estimate
BKK	5.8	3.7	64
OI	4.7	3.0	64
PV	9.7	3.2	33
CB	1.1	*	*
POD	1.3	*	*

* not determined because of insufficient samples

Several possible reasons for the large differences in the estimated volume flow rates are:

a. Errors resulting form the extrapolation of 5 sampling days to an average basis

b. Not all hazardous wastes were accounted for during the sampling period due to:

   (1) some trucks were missed because of a large number of simultaneous arrivals;

   (2) some haulers avoided State monitoring personnel:

   (3) "off hours" dumping.

c. Errors made by site operators in estimating total input

d. Some wastes entering the landifll were recorded as non-hazardous.

A total of 3,366 metal analyses were performed during the course of this study (99 samples, 17 sediments, soluble and total concentration). Estimates were made for the average daily deposition of 17 metal species, average metal concentration, and average percent concentration of these species in the soluble phase. The results are presented in four general categories: (1) individual sites, (2) combined sites, (3) industry types, and (4) related industries.

INDIVIDUAL SITES

Hazardous wastes are often a complex mixture of solid, aqueous, and organic liquid phases. The phase distribution, acid/base equivalents, range of pH and flash point for the volume sampled, and estimated daily input of liquids and solids are summarized for the five sites (Table 2).

The data suggest that different types of industrial wastes at individual sites are major contributors to the total hazardous waste stream input. For example, over 90% of the total volume input at P.O.D. are acidic liquid wastes. The low range of pH values, i.e., 1 to 4, indicates the presence of strong mineral acids. The B.K.K. site is characterized by a relatively low 62% aqueous volume input. The 18% liquid organic phase, 23% of which is volatile (B. Pt. less than 95°C), is much larger than the values obtained for the other sites.

The wide range of parameter values in Table 2 is consistent with the varying volume percent contributions of different industry types at specific sites as shown in Table 3. The Calabasas site is not included in Table 3 because only three samples were collected.

The B.K.K. site is of particular interest because it is one of the largest waste disposal areas in the Western United States. It averages about 5.8 x 10^5 l/day of industrial wastes. Approximately 60% of this volume is classified by the California State Department of Health as hazardous. This volume represents about 30% of the liquid industrial waste disposed of in the Los Angeles area and approximately 45% of the total hazardous wastes.[27]

TABLE 2. GENERAL CHARACTERISTICS OF SAMPLED VOLUME AND ESTIMATED DAILY INPUTS INTO CLASS I LANDFILLS

Site	Volume Sampled																Flash Pt. Range °C	pH Range
	Phase Distribution							Solids					Acidity		Alkalinity			
	Total	Aqueous		Organic Phase		Volatile Organic B. Pt.< 95°C		Total	Soluble		Insoluble							
	(a)	(a)	(b)	(a)	(b)	(a)	(c)	(d)	(d)	(e)	(d)	(e)	(f)	(g)	(f)	(g)		
PV	1660	1180	71	79	4.7	6.6	8.4	380	29	7.6	350	92.4	2.8×10^3	1.7	180	0.11	32-93	1.18-11.5
OI	1140	743	65	40	3.5	1.5	3.8	1250	970	78	280	22	8.4×10^3	7.4	1.1×10^5	97	17-88	3-12
BKK	1710	1060	62	306	18	71	22.9	570	220	39	350	61	6.5×10^4	38	9.4×10^4	55	24-93	1.1-13
CB	46	40	87	0.8	1.7	(h)	(h)	6	1	17	5	83	(h)	(h)	(h)	(h)	---	5-11
POD	108	101	94	(h)	(h)	(h)	(h)	30	23	77	7	23	2.9×10^5	2700	(h)	(h)	---	1-4

Site	Estimated Daily Input (i)						
	Phase Distribution				Solids		
	Total	Aqueous	Organic Phase	Volatile Organic B. Pt.< 95°C	Total	Soluble	Insoluble
	(a)	(a)	(a)	(a)	(d)	(d)	(d)
PV	970	690	46	3.9	220	17	200
OI	470	310	17	0.62	520	400	120
BKK	580	360	110	24	190	75	120
CB	110	96	1.9	--	14	2.4	12
POD	130	120	--	--	36	28	8
Total	2300	1600	180	29	980	520	460
% Total		69.6	7.8	1.3		53.0	47.0

(a) 1×10^3

(b) % total volume

(c) % organic phase

(d) kg $\times 10^3$

(e) % total solids

(f) total equiv.

(g) meq/l

(h) negligible value

(i) based on 1974 estimated daily volume input determined by site operators

TABLE 3. INDUSTRY TYPES DISCHARGING INTO CLASS I SITES

Industry Type	% Total Volume Sampled			
	B.K.K.	O.I.	P.V.	P.O.D.
Petroleum	39.7	29.2	69.2	16.0
Chemical	37.8	10.1	2.3	0.0
Metal	4.2	10.1	1.2	39.2
Food	6.7	4.5	0.0	0.0
Industrial Cleaning	4.4	36.0	18.6	6.4
Misc./Unknown	7.2	10.1	8.8	38.4

The concentrations of metal species in each sample from O.I., B.K.K., P.V., C.B., and P.O.D. sites are given in Tables D-1, D-2, and D-3 (Appendix D). Each sample number is cross-indexed in the Manifest Summary (Appendix E) from which the industry type and volume sampled can be obtained. The weighted average concentration of metal species in the total volume sampled at each site and the estimated daily deposition of each species (total, solid, soluble) are shown in Table F-1 - F-17 (Appendix F) and Figures A-1 - A-4. The weight percent of soluble metal species discharged at each site is shown in Figures A-5 - A-8. The Calabasas site is not included because only one sample was analyzed.

The volume flow and concentration of soluble toxic metals presents a potential threat to the quality of groundwater and surface water supplies. Physical and chemical properties of the soil which may be affected include attenuation capacity, field capacity, flocculation or dispersion of clay particles, hydraulic conductivity, infiltration rates, and toxic element accumulation.

Leachate will not be produced until a sizeable portion of the landfill has reached field capacity (saturation). However, some leachate may be produced immediately after waste disposal by compaction of initially wet material or by channeling of liquid through the fills. If concentrations of hazardous wastes are high in the leachate, the soil attenuation capacity may be reached relatively quickly. The cation exchange capacity will vary with the nature and concentration of ions in solution. Clay particles may either flocculate or disperse depending upon their state of hydration and the composition of their exchangeable cations. Dispersion usually occurs with monovalent and highly hydrated cations, e.g., sodium. Conversely, flocculation occurs at high solute concentrations and/or in the presence of divalent and trivalent cations.[28] Because of the various chemical, physical, and biological processes, the hydraulic conductivity may change as liquid permeates and flows in a soil. Changes occurring in the composition of the exchangeable-ion complex, as when the leachate entering the soil has a different concentration of solutes than the original soil solution, can greatly change the hydraulic conductivity.[29-31] The detachment and migration of clay particles during prolonged flow may result in the clogging of pores. Changes in the soil permeability will affect the vertical and lateral migration rates of leachate. If ponding occurs, surface water contamination could result from runoff. Further studies on the inter-actions of hazardous wastes and soil, particularly the effect on hydraulic conductivity and particle size distribution, should be conducted.

COMBINED SITES

The minimum and maximum concentrations and weighted average of metal species in 99 samples (5 sites) are listed in Table A-4. The average daily deposition was obtained by multiplying the weighted average concentration of each element by the estimated daily volume.

The combined results for five Class I sites in the Los Angeles area are shown in Figure A-9. In Figure A-9 the unshaded portion of a histogram represents the weight of that element deposited in the dissolved fraction; the shaded portion represents that deposited with the solid fraction; together they represent the total weight deposited. From this projection, one may rank species according to theri estimated daily deposition rate:

Total: Na>Fe>Ca>Zn>K>Mg>Cu>Cr>Ni>Pb>Ba>Mn>V>Cd>As>Be>Ag

Soluble: Na>Fe>Ca>Cu>Zn>K>Cr>Mg>Ni>Pb>Mn>Ba>V>Cd>As>Ag>Be

Solid: Na>Ca>Fe>Mg>Zn>K>Pb>Cu>Cr>Ba>Ni>Mn>V>Cd>As>Be>Ag

The estimated daily mass deposition and distribution of eight toxic metal species, viz., As, Be, Ca, Cr, Cu, Pb, V, and Zn are presented in Table 4.

TABLE 4. ESTIMATED DAILY DEPOSITION AND DISTRIBUTION OF TOXIC METAL SPECIES

Metal	As	Be	Cd	Cr	Cu	Pb	V	Zn
g/day								
Total	4.9×10^3	310	7.5×10^3	2.1×10^5	2.7×10^5	6.6×10^4	9.8×10^3	4.7×10^5
Soluble	310	130	530	1.8×10^5	2.3×10^5	2.3×10^4	2.3×10^3	2.0×10^5
Solid	4.6×10^3	180	7.0×10^3	3.0×10^4	4.0×10^4	4.3×10^4	7.5×10^3	2.7×10^5
Wt.%								
Soluble	6.4	41.9	7.1	87.5	85.2	34.8	23.5	42.1
Solid	93.6	58.1	92.9	14.3	14.8	65.2	76.5	57.9

The average percent of metal species in the soluble phase is shown in Figure A-10. The data can be arranged in percent ranges (Table 5).

TABLE 5. WEIGHT PERCENT OF SOLUBLE METAL SPECIES

Metal Specie	Weight % in Soluble Phase
As, Ba, Cd	<10
Mg, V	10-30
Be, Ca, K, Mn, Na, Pb, Zn	30-50
Ag, Ni	50-70
Cr, Cu, Fe	70-90

Concentration distribution curves (total and soluble) for toxic metals in the total volume sampled at the five sites is presented in Figures A-11 - A-18. The data are summarized in Table 6.

The data in Tables 4-6 indicate that copper, chromium, and zinc represent the largest pollution loads entering the Class I sites in terms of: (1) mass deposition input; (2) weight percent in the soluble phase; and (3) load intensity, i.e., many samples had very high concentrations of copper, chromium, and zinc which could result in severe shock loading of water supplies if not attenuated or contained within the landfill site.

INDUSTRIES BY TYPE

The 320 samples collected during the study are representative of 17 designated industry types shown in Table A-5. These 17 industry types are combined into six general industry groups, viz., petroleum, chemical, metal, food, industrial, cleaning, miscellaneous/unknown. The estimated daily mass deposition of metal species (g/day) for the six general industry groups is summarized in Table 7. The estimated daily mass deposition of metal species for 17 industry types is presented in Tables A-6 - A-23 and summarized in Table A-23.

The highest average daily deposition of selected metal species generated by general industry types is listed in Table 8.

TABLE 6. SUMMARY OF TOXIC METAL CONCENTRATIONS

Metal	Maximum Conc. mg/l		Percentile Conc. (a)									
	Total	Soluble	90		80		70		60		50	
			(b)	(c)	(b)	(c)	(b)	(c)	(b)	(c)	(b)	(c)
As	210	9.5	2.5	0.25	1.3	(d)	0.94	(d)	0.67	(d)	0.44	(d)
Be	2.5	2.5	0.35	0.045	0.13	0.018	0.066	0.009	0.040	0.005	0.026	0.003
Cd	34	10	10	0.5	4.0	0.21	1.8	0.13	0.81	(d)	0.32	(d)
Cr	20,000	20,000	130	22	43	4.0	19	1.9	10	1.2	5.5	(d)
Cu	20,000	20,000	95	15	32	2.0	18	(d)	12	(d)	8.2	(d)
Pb	1300	840	110	8.0	36	2.5	17	1.2	7.4	1.0	2.5	(d)
V	310	300	5.5	0.81	3.0	0.30	2.0	0.15	1.4	(d)	1.0	(d)
Zn	14,000	5100	250	35	82	7.8	57	3.6	45	2.2	32	1.4

(a) % of samples < given concentration
(b) Total concentration, mg/l
(c) Soluble concentration, mg/l
(d) Data not plotted because of graph paper scale limitations

TABLE 7. SUMMARY: INDUSTRY TYPES DISCHARGING TO CLASS I LANDFILLS

Est. Total g/day†	Industry / Element	Petroleum		Chemical		Metal		Food		Industrial Cleaning		Miscellaneous/ Unknown	
		*	**	*	**	*	**	*	**	*	**	*	**
310	Ag	110	35.1	45	14.4	63	20.1	--	--	46	14.7	49	15.7
4.9×10^3	As	630	12.9	3.4×10^3	70.2	110	2.1	88	1.8	520	10.6	150	3.1
5.4×10^4	Ba	1.1×10^4	19.7	1.3×10^3	2.4	400	0.7	370	0.7	6.3×10^3	11.8	3.4×10^4	64.7
310	Be	140	45.8	33	10.7	19	6.3	10	3.3	51	16.5	53	17.4
2.5×10^6	Ca	1.0×10^6	41.2	3.2×10^5	13.2	3.8×10^4	1.6	2.1×10^4	0.9	1.4×10^5	5.7	9.3×10^5	37.6
7.5×10^3	Cd	4.6×10^3	61.2	160	2.0	570	7.7	24	0.3	1.9×10^3	25.3	260	3.5
2.1×10^5	Cr	2.2×10^4	10.3	5.9×10^3	2.9	1.6×10^5	76.5	1.2×10^3	0.6	1.0×10^4	4.8	1.1×10^4	5.1
2.7×10^5	Cu	6.4×10^3	2.3	5.1×10^3	1.8	4.0×10^4	14.6	570	0.2	1.1×10^4	4.0	2.1×10^5	77.1
4.5×10^6	Fe	3.3×10^5	7.4	2.8×10^5	6.2	5.3×10^5	11.9	1.8×10^4	0.4	2.5×10^5	5.7	3.1×10^6	68.6
4.3×10^5	K	2.4×10^5	55.3	1.2×10^4	2.8	2.0×10^4	4.7	2.1×10^4	4.9	8.0×10^4	18.8	5.9×10^4	13.8
4.1×10^5	Mg	2.2×10^5	53.5	4.0×10^4	9.6	1.5×10^4	3.5	9.2×10^3	2.2	5.1×10^4	12.3	7.7×10^4	18.8
3.7×10^4	Mn	9.1×10^3	25.0	1.5×10^3	4.0	3.5×10^3	9.7	540	1.5	4.2×10^3	11.6	1.8×10^4	48.2
1.1×10^7	Na	3.2×10^6	28.3	4.3×10^6	37.7	1.1×10^6	9.3	2.6×10^5	2.3	1.8×10^6	15.9	7.8×10^5	6.8
8.7×10^4	Ni	6.4×10^3	7.3	1.8×10^3	2.1	3.7×10^4	42.2	270	0.3	1.7×10^3	2.0	4.0×10^4	45.9
6.6×10^4	Pb	4.4×10^3	6.7	4.0×10^3	6.1	8.8×10^3	13.3	1.2×10^3	1.8	4.2×10^4	63.1	6.0×10^3	9.2
9.8×10^3	V	2.7×10^3	27.4	210	2.2	160	1.6	210	2.2	580	6.0	5.9×10^3	60.7
4.7×10^5	Zn	2.4×10^4	5.1	1.5×10^4	3.2	3.2×10^5	67.3	4.3×10^3	0.9	3.0×10^4	6.4	$81. \times 10^4$	17.2

* Estimated Avg. g/day (5 Class I Landfills)
** % Total
† Based on estimated daily volume determined by the California State Department of Health

† Site	1×10^3/day	Site	1×10^3/day
O.I.	470	C.B.	110
B.K.K.	580	P.O.D.	130
P.V.	970	Total	2660

TABLE 8. MAXIMUM INPUT OF METAL SPECIES CONTRIBUTED BY GENERAL INDUSTRY TYPES

Metal Species (% of Total)	Industry
Ag (35), Be (46), Ca (41), Cd (61), K (55), Mg (54)	Petroleum
As (70), Na (38)	Chemical
Ba (65), Cu (77), Fe (69), Mn (48), Ni (46), V (61)	Misc./Unknown
Cr (77), Zn (67)	Metal
Pb (63)	Industrial Cleaning
---	Food

The maximum deposition of metal species generated by 17 industry types is shown in Table 9.

TABLE 9. MAXIMUM INPUT OF METAL SPECIES CONTRIBUTED BY INDUSTRY TYPES

Metal Species (% of Total)	Industry
Ag (35), Be (25), Ca (38), K (42), Mg (39)	Petroleum Production (drilling)
As (69)	Chemical Manufacturing (general)
Ba (60)	Misc. Industry
Cd (60)	Petroleum Refining
Cr (57)	Metal Plating, Etching, Cleaning
Cu (77), Fe (67), Mn (41), Ni (46), V (59)	Unknown Industry
Na (36)	Chemical Manufacturing (pesticide)
Pb (55)	Tank Cleaning (industry unknown)
Zn (49)	Metal Foundry

The reliability of data correlation with specific industries depends on the accuracy and completeness of individual manifests. Unfortunately, some manifests encountered in this study were inadequate, e.h., 4% of the manifests did not list the company's name or type of industry; 7% of the manifests did not note the industry type or waste type. The unknown industry waste streams account for approximately 6% of the total volume sampled (Table 16): however, this volume, when adjusted for an average daily basis, represents the largest mass deposition of Cu, Fe, Mn, Ni, and V. Although the data obtained for wastes of unknown origin cannot be correlated with specific industries, it is of value in determining the total mass deposition of selected metals in Class I Landfills. Hopefully, this situation will be rectified by the recently amended Solid Waste Disposal Act[16] in which required hazardous waste manifests are defined as follows: The term 'manifest' means the form used for identifying the quantity, composition and the origin, routing and destination of hazardous waste during its transportation from the point of generation to the point of disposal, treatment, or storage.

The contribution of general industry types to the total volume input is shown in Table 10.

TABLE 10. VOLUME INPUT GENERATED BY GENERAL INDUSTRY TYPES

Industry Type	% Total Volume
Petroleum	45.9
Chemical	17.9
Metal	6.0
Food	3.6
Industrial Cleaning	17.4
Misc./Unknown	9.2
Total	100.0

Approximately one-half of the total volume of hazardous wastes was generated by the petroleum industry. About 35% was contributed by the chemical industry and industrial clenaing. The metal, food and miscellaneous/unknown industries each produced less than 10% of the total daily volume.

Approximately 70% of the estimated total volume input of 2.3×10^6 l/day is in the aqueous phase and 8% consists of an organic liquid phase, 16% of which is volatile (B. Pt. less than 95°C). The total volume input of liquid organic wastes for the combined sites is estimated to be 1.8×10^5 l/day (Table 2).

The volume percent generated by 17 industry types is presented in Table A-24 and summarized for six general industry types in Table 11.

TABLE 11. VOLUME INPUT OF LIQUID ORGANIC WASTES CONTRIBUTED BY GENERAL INDUSTRY TYPES

Industry Type	% Total Liquid Organic Volume
Petroleum	49.5
Chemical	21.4
Metal	0.7
Food	0.3
Industrial Cleaning	21.7
Misc./Unknown	6.4
Total	100.0

Table 11 shows that approximately 50% of the total organic liquid input was generated by the petroleum industry; 43% of the volume was equally divided between the chemical and industrial cleaning industries. The remaining 7% was contributed by the metal, food, and miscellaneous/unknown industries.

There are some unusual features to this industry waste composition correlation (Tables 8 and 9). These points are covered below.

1. Largest input of beryllium appears from the petroleum industry. Other studies indicate that berylliem waste primarily originates from the electronics industry.

2. Barium, vanadium, nickel and manganese are listed as industry unknown, whereas California Department of Health's experience would indicate these metals orginated primarily from the petroleum industry.

3. Chromium is listed as a waste product of the metals industry, whereas in many areas the major producer of chromium is the tanning industry.

4. Primary source of lead waste is indicated as industrial cleaning. Other data would indicate that this must correspond to tank cleaning in the petroleum industry.

The lack of substantiated data has generated many concerns over the practice of landfill disposal of hazardous wastes. Uncertainty exists as to the effectiveness of hydrogeologic isolation of the landfill in providing long-term protection of groundwater and surface water supplies. There is insufficient information on the life span of hazardous waste regarding leachate generating capabilities. Additionally, many questions exist regarding the migration of soluble toxicants and transport mechanisms of hazardous wastes in contact with landfill leachates and soils of varying chemical and physical properties. The results obtained in this study, in conjunction with EPA sponsored attenuation and particulate leaching investigations, should prove useful in approximating the pollution potential of hazardous waste from selected industries.

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APPENDICES

APPENDIX A

MISCELLANEOUS TABLES AND FIGURES

TABLE A-1 SAMPLING SCHEDULE - SEPTEMBER 1975

Site \ Date	2	3	4	5	6	7	8	9	10	11	12	Total Days
BKK	X	X					X		X		X	5
OI	X	X					X			X		4
PV			X	X				X	X		X	5
POD			X	X				X		X		4

TABLE A-2 SAMPLING EQUIPMENT

Equipment List
Sampling: 1. Three (3) sample tubes 2. Sample bottles 3. Funnels 4. Tube Cleaners 5. Disposable wipers 6. Drums, 1-55 gal.; 3-5 gal. pails 7. 5 gal.-1,1,1, Trichloro Ethane 8. Spares: tubes 9. Spares: rods 10. Spares: stoppers 11. Ink pens: Mark-on-anything 12. Tool Kit 13. Clip Board 14. Analytical forms 15. First Aid Kit
Personnel: each team 3 protective suits 2 hard hats with shields boots for each sampler/nor necessary for record keeper 2 respirators 4 pair gloves 2 pair goggles

TABLE A-3 OPERATING CONDITION FOR ATOMIC ABSORPTION SPECTROPHOTOMETER

Analytical Method	Element	D_2 Arc Used	Wavelength (1) NM	Slit Width NM	Sensitivity gm/ml	Flame Type	
	Mg	-	285.2	0.7	0.3	Oxidizing	
Atomic	Ca	-	422.7	0.7	0.08	Reducing	
Absorption	Cr	-	357.9	0.7	0.1	Reducing	
Spectrophotometry	Mn	+	279.5	0.2	0.05	Oxidizing	
by Direct	Fe	+	248.3	0.2	0.12	Oxidizing	
Aspiration	Ni	+	232	0.2	0.15	Oxidizing	
into an	Cu	-	324.7	0.7	0.1	Oxidizing	
Air-acetylene	Zn	+	213.9	0.7	0.02	Oxidizing	
Flame	Ag	-	328.1	0.7	0.06	Oxidizing	
	Pb	+	283.3	0.7	0.5	Oxidizing	
Emission	Na	-	589	0.7	1	Oxidizing	
Flame	K	-	766.5	0.7		Oxidizing	
Photometry		-					
					Drying Temp C^o	Char Temp ^oC	Atom Temp ^oC
Heated	Be	-	234.9	0.7	110	1200	2700
Graphite	V	-	318.4	0.2	110	1700	2700
Furnace	As	+	193.7	0.7	110	950	2700
Atomization	Cd	+	228.8	0.7	100	250	2100
Ar	Ba	-	553.6	0.2	110	1600	2700

gas-normal flow

TÁBLE A-4 RANGES AND WEIGHTED AVERAGES OF METAL CONCENTRATIONS FOUND IN HAZARDOUS WASTE SAMPLES, mg/l (5 SITES)

	Dissolved Sample Concentrations*			Total Sample Concentrations		
Element	Average	Maximum	Minimum	Average	Maximum	Minimum
Be	0.079	2.5	-	0.14	2.4	-
Na	4,300	26,000	-	5,500	43,000	11
Mg	62	2,000	-	170	2,300	-
K	110	2,400	-	170	1,400	-
Ca	540	35,000	-	970	24,000	-
V	1.4	300	-	3.8	310	-
Cr	111	20,000	-	94.2	19,000	-
Mn	9.2	830	-	14	820	-
Fe	2,100	170,000	-	1,760	140,000	5
Ni	37	2,600	-	35	2,100	-
Cu	140	20,000	-	110	20,000	-
Zn	120	5,100	-	200	14,000	-
As	0.19	9.5	-	2.9	210	-
Ag	0.11	2.9	-	0.13	2.9	-
Cd	0.32	10	-	2.8	34	-
Ba	0.62	9.5	-	16	610	-
Pb	14	840	-	26	1,300	-

\- Below detection limit
* Based on liquid volume

TABLE A-5 INDUSTRY TYPES DISCHARGING TO CLASS I LANDFILLS

Code	Industry Type	% Total Volume
1	Petroleum Production (drilling)	17.3
2	Petroleum Refining	27.7
3	Petrochemical	0.9
4	Chemical Manufacturing (general)	3.9
5	Chemical Manufacturing (pesticide)	11.2
6	Paint Manufacturing	2.8
7	Metal Plating, Etching, Cleaning	4.0
8	Metal Foundry	2.0
9	Equipment Cleaning	6.3
10	Tank Cleaning (petroleum industry)	2.4
11	Tank Cleaning (industry unknown)	5.3
12	Ship Bilge Cleaning	0.8
13	Vehicle Cleaning	2.6
14	Food Industry	3.6
15	Paper Manufacturing	0.2
16	Miscellaneous Industry	3.5
17	Unknown Industry	5.5
	Total	100.0

Summary

Petroleum	45.9
Chemical	17.9
Metal	6.0
Food	3.6
Industrial Cleaning	17.4
Miscellaneous /Unknown	9.2
Total	100.0

TABLE A-6 PETROLEUM PRODUCTION (DRILLING) CODE 1

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 2	0.28	110	35.1
As	0.2 - 2.8	1.2	470	9.6
Ba	1.2 - 92	20	7.8×10^3	14.6
Be	0.01 - 0.4	0.20	78	25.4
Ca	58 - 7400	2400	9.3×10^5	37.8
Cd	* - 1	0.15	58	0.8
Cr	* - 298	39	1.5×10^4	7.0
Cu	* - 19	3.6	1.4×10^3	0.5
Fe	24 - 1300	540	2.1×10^5	4.7
K	68 - 820	460	1.8×10^5	42.1
Mg	80 - 990	420	1.6×10^5	38.7
Mn	* - 49	18	7.0×10^3	19.3
Na	630 - 18,000	5000	1.9×10^6	16.7
Ni	* - 23	12	4.7×10^3	5.4
Pb	* - 24	2.6	1.0×10^3	1.5
V	* - 7	5.0	1.9×10^3	19.5
Zn	4.8 - 74	42	1.6×10^4	3.4

* Below Detection Limit

TABLE A-7 PETROLEUM REFINING CODE 2

Element	Range mg/l	Wt. Avg mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	* - 2	0.22	140	2.9
Br	0.1 - 20	4.4	2.7×10^3	5.1
Be	* - 0.4	0.10	62	20.2
Ca	4 - 1600	97	6.1×10^4	2.5
Cd	* - 34	7.2	4.5×10^3	60.4
Cr	* - 51	11	6.9×10^3	3.2
Cu	* - 30	8.0	5.0×10^3	1.8
Fe	18 - 960	190	1.2×10^5	2.7
K	6 - 490	88	5.5×10^4	12.9
Mg	* - 740	86	5.4×10^4	13.1
Mn	* - 21	3.0	1.9×10^3	5.2
Na	90 - 5500	1700	1.1×10^6	9.7
Ni	* - 7.5	2.5	1.6×10^3	1.8
Pb	* - 44	5.4	3.4×10^3	5.2
V	* - 8.2	1.2	750	7.7
Zn	0.5 - 71	12	7.5×10^3	1.6

* Below Detection Limit

TABLE A-8 PETROCHEMICAL CODE 3

Element	Range mg/l	Wt. Avg mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	0.8 - 1.0	0.9	17	0.4
Ba	0.19 - 0.96	0.43	8.2	--
Be	0.030 - 0.036	0.034	0.65	0.2
Ca	96 - 3400	1100	2.1×10^4	0.9
Cd	*	--	--	--
Cr	3.8 - 29	12	230	0.1
Cu	1 - 2.9	2.3	44	--
Fe	38 - 240	100	1.9×10^3	--
K	68 - 72	71	1.4×10^3	0.3
Mg	270 - 400	370	7.0×10^3	1.7
Mn	9.6 - 9.8	9.7	180	0.5
Na	4900 - 9600	8200	1.6×10^5	1.4
Ni	2.9 - 3.8	3.5	67	0.1
Pb	*	--	--	--
V	1.0	1.0	19	0.2
Zn	9.6 - 16	12	230	0.1

* Below Detection Limit

TABLE A-9 CHEMICAL MANUFACTURING (GENERAL) CODE 4

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 2.9	0.37	32	10.2
As	* - 210	39	3.4×10^3	69.4
Ba	0.21 - 9.5	4.6	400	0.8
Be	0.01 - 2.4	0.29	25	8.1
Ca	30 - 24,000	2700	2.4×10^5	9.8
Cd	* - 0.31	0.076	6.6	0.1
Cr	* - 290	35	3.1×10^3	1.5
Cu	* - 330	41	3.6×10^3	1.3
Fe	59 - 19,000	2500	2.2×10^5	4.9
K	0.31 x 150	38	3.3×10^3	0.8
Mg	10 - 2300	320	2.8×10^4	6.8
Mn	* - 23	6.4	560	1.5
Na	50 - 7500	1700	1.5×10^5	1.3
Ni	* - 8	4.3	370	0.4
Pb	* - 23	8.8	770	1.2
V	* - 4.4	1.9	170	1.8
Zn	11 - 69	30	2.6×10^3	0.6

* Below Detection Limit

TABLE A-10 CHEMICAL MANUFACTURING (PESTICIDE) CODE 5

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 0.09	0.05	13	4.2
As	* - 0.31	0.11	28	0.6
Ba	1.6 - 3.7	3.0	760	1.4
Be	0.017 - 0.31	0.029	7.4	2.4
Ca	45 - 360	230	5.8×10^4	2.4
Cd	* - 0.33	0.19	48	0.6
Cr	2.8 - 11	7.0	1.8×10^3	0.9
Cu	0.28 - 5.7	1.5	380	0.1
Fe	110 - 330	135	3.4×10^4	0.8
K	* - 30	16	4.1×10^3	1.0
Mg	14 - 67	17	4.3×10^3	1.0
Mn	0.46 - 3.7	1.9	480	1.3
Na	260 - 35,000	16,000	4.1×10^6	36.0
Ni	4.8 - 6.5	5.6	1.4×10^3	1.6
Pb	* - 1.9	0.83	210	0.3
V	* - 0.28	0.16	41	0.4
Zn	2.8 - 5.3	4.3	1.1×10^3	0.2

* Below Detection Limit

TABLE A-11 PAINT MANUFACTURING CODE 6

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	* - 0.6	0.19	12	0.2
Ba	0.71 - 4.6	2.0	130	0.2
Be	0.002 - 0.011	0.0071	0.45	0.2
Ca	120 - 1500	380	2.4×10^4	1.0
Cd	* - 5.8	1.6	100	1.3
Cr	0.76 - 44	16	1.0×10^3	0.5
Cu	* - 44	18	1.1×10^3	0.4
Fe	20 - 930	350	2.2×10^4	0.5
K	19 - 140	70	4.4×10^3	1.0
Mg	18 - 460	120	7.6×10^3	1.8
Mn	0.31 - 18	6.7	430	1.2
Na	160 - 1500	670	4.3×10^4	0.4
Ni	* - 2.9	0.86	55	0.1
Pb	* - 130	47	3.0×10^3	4.6
V	* - 0.4	0.048	3.0	--
Zn	4.6 - 480	180	1.1×10^4	2.4

* Below Detection Limit

TABLE A-12 METAL PLATING, ETCHING, CLEANING CODE 7

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 0.9	0.24	22	7.0
As	* - 2.9	0.83	75	1.5
Ba	0.19 - 7.8	3.2	290	0.5
Be	0.003 - 0.95	0.20	18	5.9
Ca	14 - 1400	340	3.1×10^4	1.3
Cd	* - 14	3.4	310	4.2
Cr	2.6 - 19,000	1800	1.6×10^5	75.1
Cu	3.7 - 780	320	2.9×10^4	10.6
Fe	18 - 20,000	5300	4.8×10^5	10.8
K	* - 670	150	1.4×10^4	3.3
Mg	5.5 - 410	110	9.9×10^3	2.4
Mn	* - 160	19	1.7×10^3	4.7
Na	40 - 17,000	4000	3.6×10^5	3.2
Ni	* - 1200	270	2.4×10^4	27.5
Pb	10 - 220	57	5.1×10^3	7.7
V	* - 4.5	1.3	120	1.2
Zn	2.4 - 4700	950	8.6×10^4	18.3

* Below Detection Limit

TABLE A-13 METAL FOUNDRY CODE 8

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 2.7	0.77	41	13.1
As	0.4 - 0.5	0.57	31	0.6
Ba	0.42 - 9.8	2.1	110	0.2
Be	0.005 - 0.054	0.024	1.3	0.4
Ca	44 - 170	130	7.0×10^3	0.3
Cd	0.3 - 13	4.9	260	3.5
Cr	* - 190	55	3.0×10^3	1.4
Cu	1 - 720	210	11×10^3	4.0
Fe	240 - 2100	880	4.7×10^4	1.1
K	31 - 230	110	5.9×10^3	1.4
Mg	8.8 - 110	87	4.7×10^3	1.1
Mn	16 - 80	34	1.8×10^3	5.0
Na	200 - 43,000	13,000	7.0×10^5	6.1
Ni	* - 850	250	1.3×10^4	14.9
Pb	3 - 160	68	3.7×10^3	5.6
V	0.07 - 3.2	0.75	40	0.4
Zn	5.2 - 14,000	4200	2.3×10^5	49.0

* Below Detection Limit

TABLE A-14 EQUIPMENT CLEANING CODE 9

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	* - 10	1.3	190	3.9
Ba	0.04 - 5.1	2.3	330	0.6
Be	0.002 - 0.32	0.024	3.4	1.1
Ca	5.2 - 2000	210	3.0×10^4	1.2
Cd	* - 17	4.3	610	8.2
Cr	* - 41	7.9	1.1×10^3	0.5
Cu	* - 500	33	4.7×10^3	1.7
Fe	5 - 2300	500	7.1×10^4	1.6
K	* - 350	86	1.2×10^4	2.8
Mg	15 - 240	69	9.8×10^3	2.4
Mn	* - 52	6.7	960	2.6
Na	11 - 5400	870	1.2×10^5	1.1
Ni	* - 14	1.9	270	0.3
Pb	* - 130	12	1.7×10^3	2.6
V	* - 2	0.49	70	0.7
Zn	0.54 - 270	28	4.0×10^3	0.9

* Below Detection Limit

TABLE A-15 TANK CLEANING (PETROLEUM INDUSTRY) CODE 10

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	0.96 - 1.9	1.3	69	1.4
Ba	4.7 - 140	88	4.7×10^3	8.8
Be	0.1 - 0.36	0.34	18	5.9
Ca	* - 1400	910	4.9×10^4	2.0
Cd	0.24 - 1.0	0.49	26	0.4
Cr	2.1 - 52	42	2.2×10^3	1.0
Cu	8.6 - 27	10	530	0.2
Fe	390 - 1000	990	5.3×10^4	1.2
K	100 - 360	320	1.7×10^4	4.0
Mg	62 - 480	360	1.9×10^4	4.6
Mn	2.1 - 54	40	2.1×10^3	5.8
Na	1500 - 3800	2600	1.4×10^5	1.2
Ni	2.1 - 7.2	6.2	330	0.4
Pb	* - 94	5.3	280	0.4
V	0.21 - 4.8	4.6	250	2.6
Zn	9.5 - 68	48	2.6×10^3	0.6

* Below Detection Limit

TABLE A-16 TANK CLEANING (INDUSTRY UNKNOWN) CODE 11

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 0.97	0.38	46	14.7
As	* - 4.4	2.1	250	5.1
Ba	0.85 - 17	5.6	680	1.3
Be	0.019 - 0.21	0.097	12	3.9
Ca	16 - 3100	410	4.9×10^4	2.0
Cd	* - 23	8.6	1.0×10^3	13.4
Cr	2 - 130	55	6.6×10^3	3.1
Cu	2 - 110	35	4.2×10^3	1.5
Fe	110 - 3100	860	1.0×10^5	2.3
K	15 - 450	280	3.4×10^4	7.9
Mg	26 - 250	120	1.5×10^4	3.6
Mn	0.56 - 26	6.5	780	2.2
Na	460 - 23,000	12,000	1.5×10^6	13.2
Ni	* - 15	7.1	860	1.0
Pb	* - 940	300	3.6×10^4	54.6
V	0.9 - 3.7	1.7	210	2.2
Zn	5.1 - 980	130	1.6×10^4	3.4

* Below Detection Limit

TABLE A-17 SHIP BILGE CLEANING CODE 12

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	*	--	--	--
Ba	1.2 - 4.6	3.0	52	0.1
Be	0.020 - 1.8	0.96	17	5.5
Ca	15 - 2.8	22	380	--
Cd	* - 4.6	2.4	42	0.6
Cr	0.57 - 1.0	0.78	14	--
Cu	0.063 - 6.4	3.3	57	--
Fe	11 - 37	24	420	--
K	26 - 370	190	3.3×10^3	0.8
Mg	11 - 41	27	470	0.1
Mn	* - 1.7	0.90	16	--
Na	520 - 530	530	9.2×10^3	0.1
Ni	*	--	--	--
Pb	*	--	--	--
V	0.025 - 0.89	0.49	8.5	0.1
Zn	0.06 - 450	240	4.2×10^3	0.9

* Below Detection Limit

TABLE A-18 VEHICLE CLEANING CODE 13

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	* - 0.7	0.20	12	0.2
Ba	1.1 - 22	9.2	530	1.0
Be	0.0014 - 0.013	0.0065	0.38	0.1
Ca	28 - 800	200	1.2×10^4	0.5
Cd	* - 8.2	3.4	200	2.7
Cr	0.38 - 19	6.3	370	0.2
Cu	1 - 93	27	1.6×10^3	0.6
Fe	68 - 780	430	2.5×10^4	0.6
K	130 - 410	240	1.4×10^4	3.3
Mg	15 - 230	110	6.4×10^3	1.6
Mn	0.44 - 12	6.0	350	1.0
Na	110 - 1600	590	3.4×10^4	0.3
Ni	* - 11	4.6	270	0.3
Pb	* - 200	62	3.6×10^3	5.5
V	* - 3	0.73	42	0.4
Zn	11 - 120	46	2.7×10^3	0.6

* Below Detection Limit

TABLE A-19 FOOD INDUSTRY CODE 14

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	* - 6.6	1.1	88	1.8
Ba	0.26 - 13	4.6	370	0.7
Be	0.002 - 0.89	0.13	10	3.3
Ca	9.6 - 900	260	2.1×10^4	0.9
Cd	* - 1.8	0.30	24	0.3
Cr	* - 100	15	1.2×10^3	0.6
Cu	0.4 - 42	7.1	570	0.2
Fe	22 - 720	220	1.8×10^4	0.4
K	* - 1200	260	2.1×10^4	4.9
Mg	* - 530	115	9.2×10^3	2.2
Mn	* - 10	6.7	540	1.5
Na	92 - 15,000	3300	2.6×10^5	2.3
Ni	* - 10	3.4	270	0.3
Pb	* - 150	15	1.2×10^3	1.8
V	* - 12	2.6	210	2.2
Zn	13 - 160	53	4.3×10^3	0.9

* Below Detection Limit

TABLE A-20 PAPER MANUFACTURING CODE 15

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	0.4 - 0.6	0.47	2.3	0.1
Ba	6.1 - 7.8	6.8	33	0.1
Be	* - 0.12	0.062	0.30	0.1
Ca	* - 2100	1100	5.3×10^3	0.2
Cd	0.05 - 1.2	0.56	2.7	--
Cr	88 - 220	150	720	0.3
Cu	14 - 390	180	860	0.3
Fe	91 - 230	150	720	--
K	12 - 15	13	62	--
Mg	12 - 75	44	210	0.1
Mn	2 - 2.3	2.0	9.6	--
Na	41 - 300	180	860	--
Ni	* - 1.5	0.83	4.0	--
Pb	920 - 1300	1100	5.3×10^3	8.0
V	*	--	--	--
Zn	12 - 76	40	190	--

* Below Detection Limit

TABLE A-21 MISCELLANEOUS INDUSTRY CODE 16

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	*	--	--	--
As	* - 2	0.33	26	0.5
Ba	0.23 - 610	400	3.2×10^4	59.9
Be	0.002 - 0.53	0.076	6.0	2.0
Ca	240 - 15,000	6600	5.2×10^5	21.1
Cd	* - 0.71	0.48	38	0.5
Cr	0.2 - 9.1	6.9	540	0.3
Cu	0.3 - 25	5.1	400	0.2
Fe	28 - 3900	640	5.1×10^4	1.2
K	6.2 - 1370	230	1.8×10^4	4.2
Mg	16 - 1100	360	2.8×10^4	6.8
Mn	0.6 - 130	31	2.5×10^3	6.9
Na	24 - 3600	2900	2.3×10^5	2.0
Ni	* - 4	0.36	28	--
Pb	* - 7	5.4	430	0.7
V	* - 14	2.5	200	2.1
Zn	1 - 1100	130	1.0×10^4	2.1

* Below Detection Limit

TABLE A-22 UNKNOWN INDUSTRY CODE 17

Element	Range mg/l	Wt. Avg. mg/l	Est. gm/day	% Total
Ag	* - 1.1	0.39	49	15.7
As	* - 2.8	0.93	120	2.5
Ba	1.3 - 110	20	2.5×10^3	4.7
Be	0.005 - 2.1	0.38	47	15.3
Ca	3.4 - 13,000	3200	4.0×10^5	16.3
Cd	0.063 - 10	1.8	220	3.0
Cr	1.1 - 460	77	9.6×10^3	4.5
Cu	1.9 - 20,000	1700	2.1×10^5	76.6
Fe	25 - 140,000	24,000	3.0×10^6	67.4
K	5.6 - 870	330	4.1×10^4	9.6
Mg	3.4 - 1400	390	4.9×10^4	11.9
Mn	0.19 - 820	120	1.5×10^4	41.3
Na	130 - 8600	4400	5.5×10^5	4.8
Ni	0.25 - 2100	320	4.0×10^4	45.9
Pb	* - 17	2.5	310	0.5
V	* - 310	46	5.7×10^3	58.6
Zn	0.38 - 5100	570	7.1×10^4	15.1

* Below Detection Limit

TABLE A-23 INDUSTRY TYPES DISCHARGING TO CLASS I LANDFILLS

Est. Total g/day	Element	Petroleum Production (drilling)		Petroleum Refining		Petrochemical		Chemical Manufacturing (general)		Chemical Manufacturing (Pesticide)		Paint Manufacturing		Metal Plating, Etching, Cleaning	
		*	**	*	**	*	**	*	**	*	**	*	**	*	**
310	Ag	110	35.1	--	--	--	--	32	10.2	13	4.2	--	--	22	7.0
4.9×10^3	As	470	9.6	140	2.9	17	0.4	3.4×10^4	69.4	28	0.6	12	0.2	75	1.5
5.4×10^4	Ba	7.8×10^3	14.6	2.7×10^3	5.1	8.2	--	400	0.8	760	1.4	130	0.2	290	0.5
310	Be	78	25.4	62	20.2	0.65	0.2	25	8.1	7 4	2.4	0.45	0.2	18	5.9
2.5×10^6	Ca	9.3×10^5	37.8	6.1×10^4	2.5	2.1×10^4	0.9	2.4×10^5	9.8	5.8×10^4	2.4	2.4×10^4	1.0	3.1×10^4	1.3
7.5×10^3	Cd	58	0.8	4.5×10^3	60.4	--	--	6.6	0.1	48	0.6	100	1.3	310	4.2
2.1×10^5	Cr	1.5×10^4	7.0	6.9×10^3	3.2	230	0.1	3.1×10^3	1.5	1.8×10^3	0.9	1.0×10^3	0.5	1.6×10^5	75.1
2.7×10^5	Cu	1.4×10^3	0.5	5.0×10^3	1.8	44	--	3.6×10^3	1.3	380	0.1	1.1×10^3	0.4	2.9×10^4	10.6
4.5×10^6	Fe	2.1×10^5	4.7	1.2×10^5	2.7	1.9×10^3	--	2.2×10^5	4.9	3.4×10^4	0.8	2.2×10^4	0.5	4.8×10^5	10.8
4.3×10^5	K	1.8×10^5	42.1	5.5×10^4	12.9	1.4×10^3	0.3	3.3×10^3	0.8	4.1×10^3	1.0	4.4×10^3	1.0	1.4×10^4	3.3
4.1×10^5	Mg	1.6×10^5	38.7	5.4×10^4	13.1	7.0×10^3	1.7	2.8×10^4	6.8	4.3×10^3	1.0	7.6×10^3	1.8	9.9×10^3	2.4
3.7×10^4	Mn	7.0×10^3	19.3	1.9×10^3	5.2	180	0.5	560	1.5	480	1.3	430	1.2	1.7×10^3	4.7
1.7×10^7	Na	1.9×10^6	16.7	1.1×10^6	9.7	1.6×10^5	1.4	1.5×10^5	1.3	4.1×10^6	36	4.3×10^4	0.4	3.6×10^5	3.2
8.7×10^4	Ni	4.7×10^3	5.4	1.6×10^3	1.8	67	0.1	370	0.4	1.4×10^3	1.6	55	0.1	2.4×10^4	27.5
6.6×10^4	Pb	1.0×10^3	1.5	3.4×10^3	5.2	--	--	770	1.2	210	0.3	3.0×10^3	4.6	5.1×10^3	7.7
9.8×10^3	V	1.9×10^3	19.5	750	7.7	19	0.2	170	1.8	41	0.4	3.0	--	120	1.2
4.7×10^5	Zn	1.6×10^4	3.4	7.5×10^3	1.6	230	0.1	2.6×10^3	0.6	1.1×10^3	0.2	1.1×10^4	2.4	8.6×10^4	18.3

* Avg. g/day (5 Class I Landfills)
** % Total

TABLE A-23 INDUSTRY TYPES DISCHARGING TO CLASS I LANDFILLS - CONTINUED

Metal Foundry		Equipment Cleaning		Tank Cleaning (Petroleum) Industry		Tank Cleaning (Industry Unknown)		Ship Bilge Cleaning		Vehicle Cleaning		Food Industry		Paper Manufacturing		Miscellaneous Industry		Unknown Industry	
*	**	*	**	*	**	*	**	*	**	*	**	*	**	*	**	*	**	*	**
41	13.1	--	--	--	--	46	14.7	--	--	--	--	--	--	--	--	--	--	49	15.7
31	0.6	190	3.9	69	1.4	250	5.1	--	--	12	0.2	88	1.8	2.3	0.1	26	0.5	120	2.5
110	0.2	330	0.6	4.7×10^3	8.8	680	1.3	52	0.1	530	1.0	370	0.7	33	0.1	3.2×10^4	59.9	2.5×10^3	4.7
1.3	0.4	3.4	1.1	18	5.9	12	3.9	17	5.5	0.38	0.1	10	3.3	0.3	0.1	6.0	2.0	47	15.3
7.0×10^3	0.3	3.0×10^4	1.2	4.9×10^4	2.0	4.9×10^4	2.0	380	--	1.2×10^4	0.5	2.1×10^4	0.9	5.3×10^3	0.2	5.2×10^5	21.1	4.0×10^5	16.3
260	3.5	610	8.2	26	0.4	1.0×10^3	13.4	42	0.6	200	2.7	24	0.3	27	--	38	0.5	220	3.0
3.0×10^3	1.4	1.1×10^3	0.5	2.2×10^3	1.0	6.6×10^3	3.1	14	--	370	0.2	1.2×10^3	0.6	720	0.3	540	0.3	9.6×10^3	4.5
1.1×10^4	4.0	4.7×10^3	1.7	530	0.2	4.2×10^3	1.5	57	--	1.6×10^3	0.6	570	0.2	860	0.3	400	0.2	2.1×10^5	76.6
4.7×10^4	1.1	7.1×10^4	1.6	5.3×10^4	1.2	1.0×10^5	2.3	420	--	2.5×10^4	0.6	1.8×10^4	0.4	720	--	5.1×10^4	1.2	3.0×10^6	67.4
5.9×10^3	1.4	1.2×10^4	2.8	1.7×10^4	4.0	3.4×10^4	7.9	3.3×10^3	0.8	6.4×10^4	3.3	2.1×10^4	4.9	62	--	1.8×10^4	4.2	4.1×10^4	9.6
4.7×10^3	1.1	9.8×10^3	2.4	1.9×10^4	4.6	1.5×10^4	3.6	470	0.1	6.4×10^3	1.6	9.2×10^3	2.2	210	0.1	2.8×10^4	6.8	4.9×10^4	11.9
1.8×10^3	5.0	960	2.6	2.1×10^3	5.8	780	2.2	16	--	350	1.0	540	1.5	9.6	--	2.5×10^3	6.9	1.5×10^4	41.3
7.0×10^5	6.1	1.2×10^5	1.1	1.4×10^5	1.2	1.5×10^6	13.2	9.2×10^3	0.1	3.4×10^4	0.3	2.6×10^5	2.3	860	--	2.3×10^5	2.0	5.5×10^5	4.8
1.3×10^4	14.9	270	0.3	330	0.4	860	1.0	--	--	270	0.3	270	0.3	4.0	--	28	--	4.0×10^4	45.9
3.7×10^3	5.6	1.7×10^3	2.6	280	0.4	3.6×10^4	54.6	--	--	3.6×10^3	5.5	1.2×10^3	1.8	5.3×10^3	8.0	430	0.7	310	0.5
40	0.4	70	0.7	250	2.6	210	2.2	8.5	0.1	42	0.4	210	2.2	--	--	200	2.1	5.7×10^3	58.6
2.3×10^5	49.0	4.0×10^3	0.9	2.6×10^3	0.6	1.6×10^4	3.4	4.2×10^3	0.9	2.7×10^3	0.6	4.3×10^3	0.9	190	--	1.0×10^4	2.1	7.1×10^4	15.1

TABLE A-24 VOLUME INPUT OF LIQUID ORGANIC WASTES CONTRIBUTED BY INDUSTRY TYPES

Industry Type	% Total Organic Liquid Volume
Petroleum Production (Drilling)	41.7
Petroleum Refining	7.7
Petrochemical	0.0
Chemical Manufacturing (General)	18.1
Chemical Manufacturing (Pesticide)	0.0
Paint Manufacturing	3.4
Metal Plating, Etching, Cleaning	0.6
Metal Foundry	0.1
Equipment Cleaning	13.1
Tank Cleaning (Petroleum Industry)	0.6
Tank Cleaning (Industry Unknown)	7.3
Ship Bilge Cleaning	0.0
Vehicle Cleaning	0.7
Food Industry	0.3
Paper Manufacturing	0.7
Miscellaneous Industry	0.7
Unknown Industry	5.0
Total	100.0

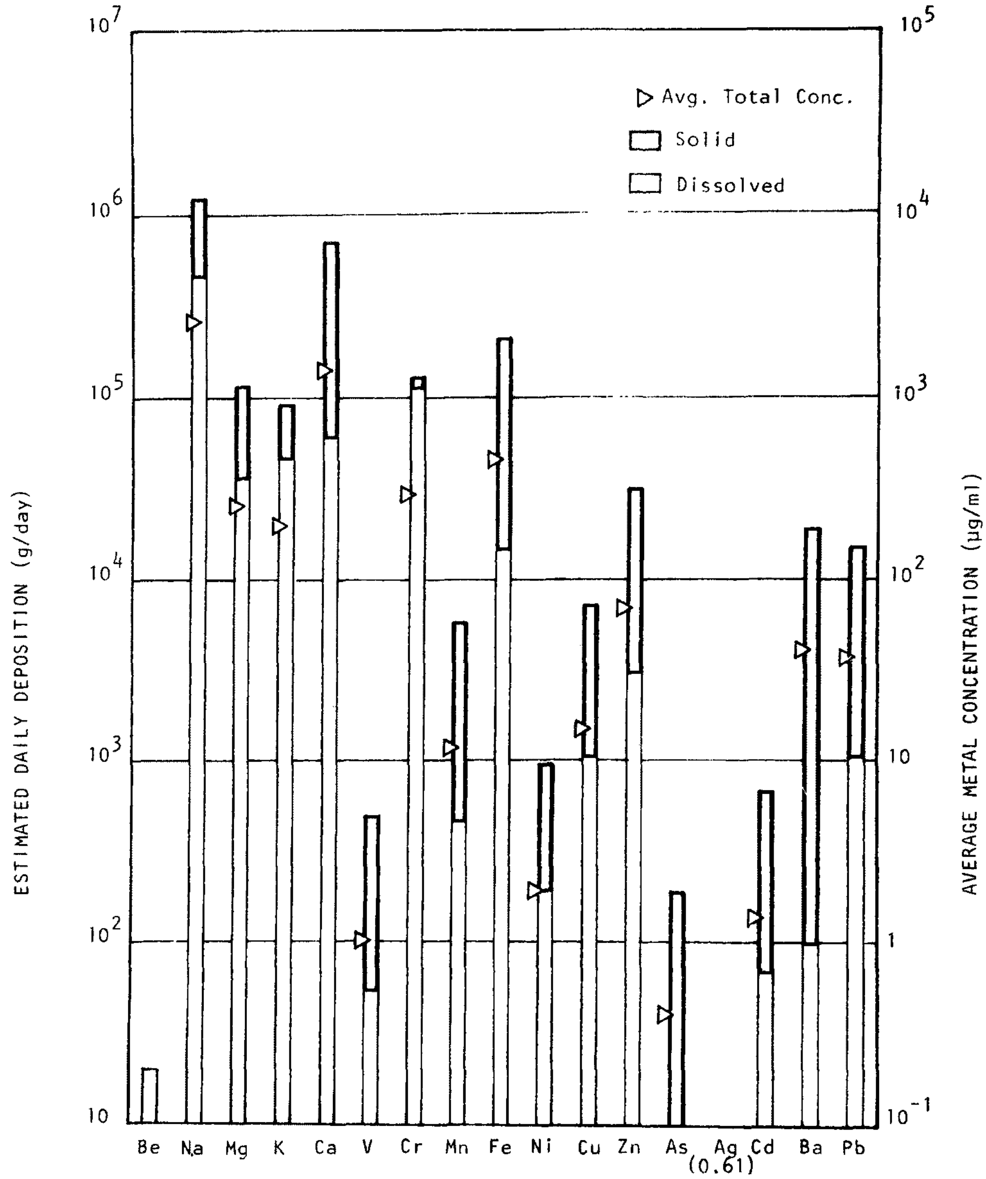


Figure A-1 Average concentration and estimated daily depositions of selected metals in hazardous wastes at the Operating Industries Sanitary Landfill.

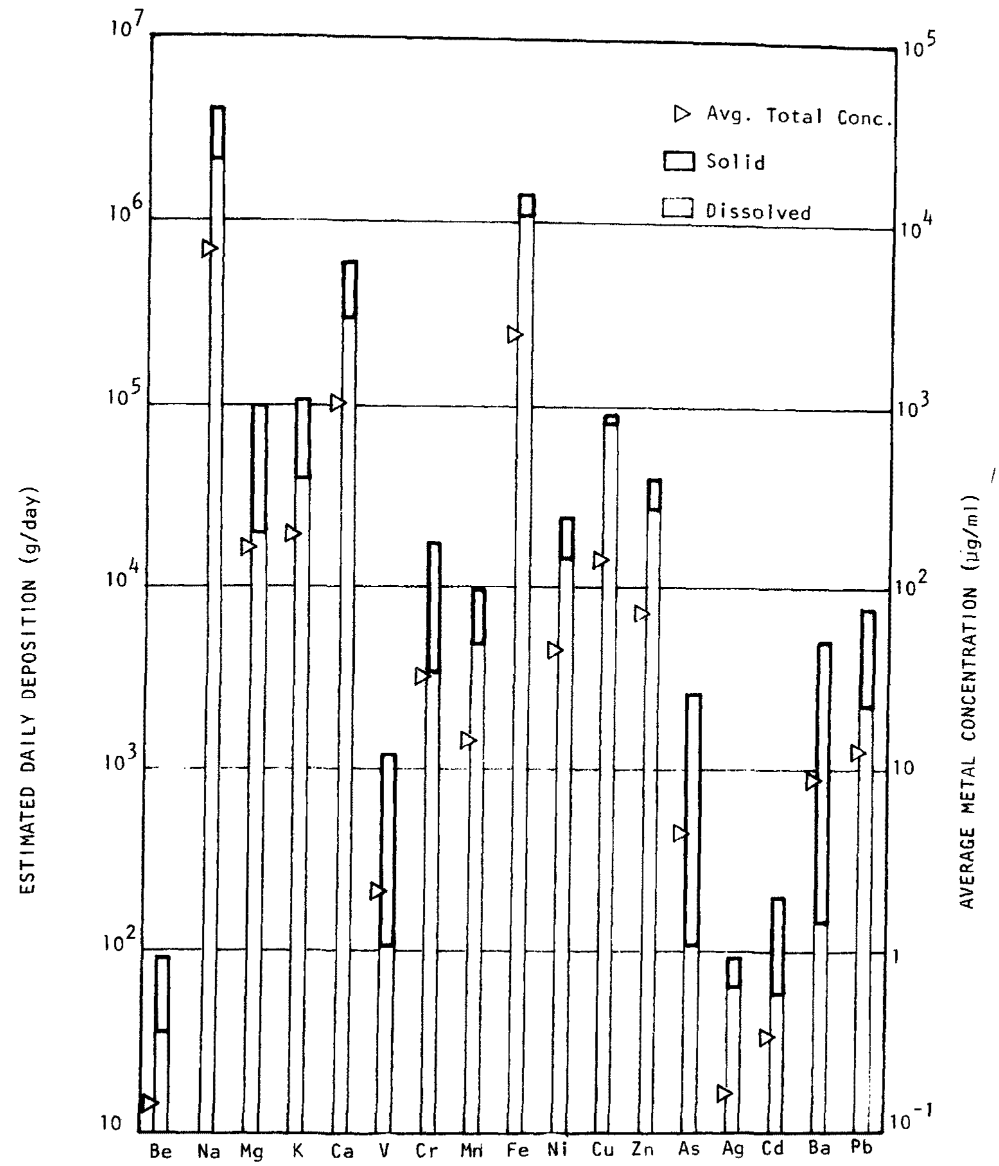


Figure A-2 Average concentration and estimated daily depositions of selected metals in hazardous wastes at the B.K.K. Sanitary Landfill.

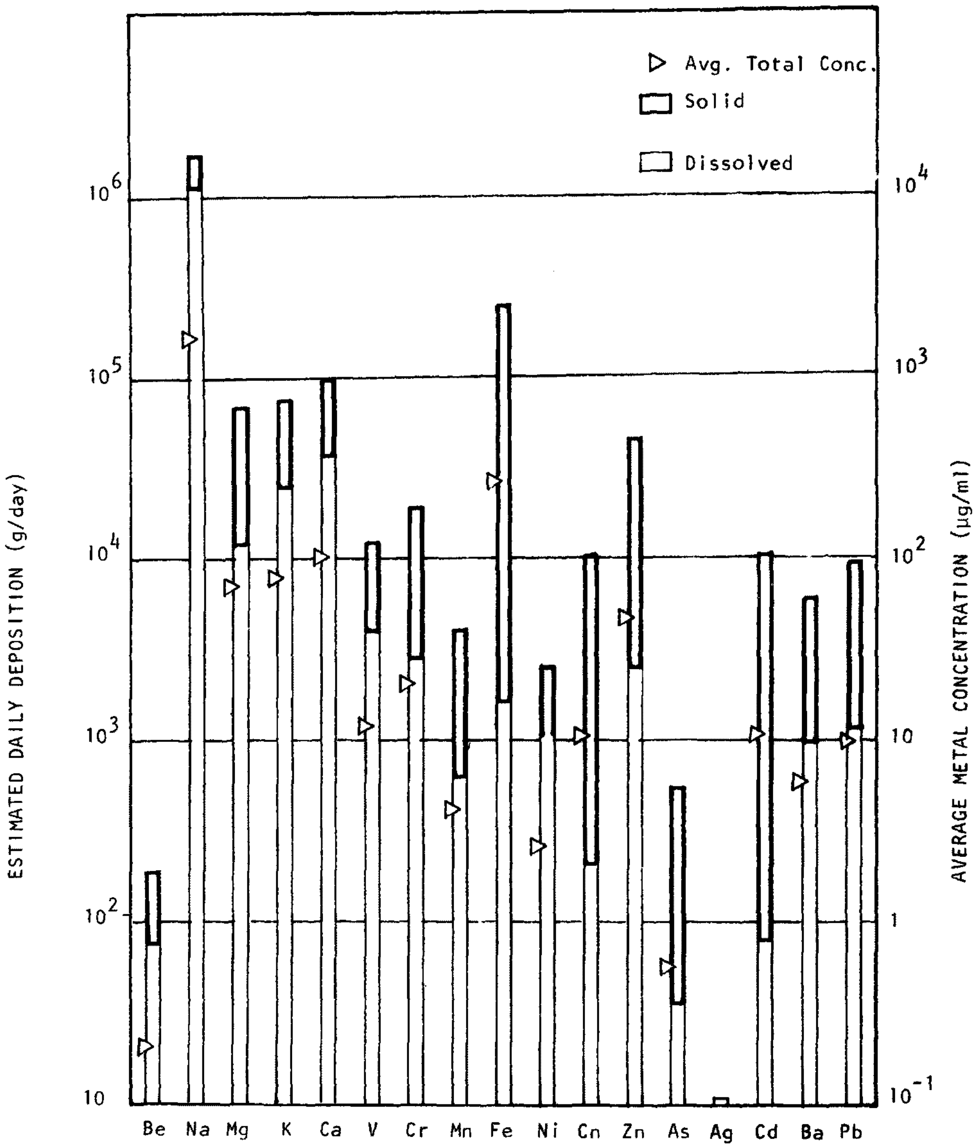


Figure A-3 Average concentration and estimated daily deposition of selected metals in hazardous wastes at the Palos Verdes Sanitary Landfill.

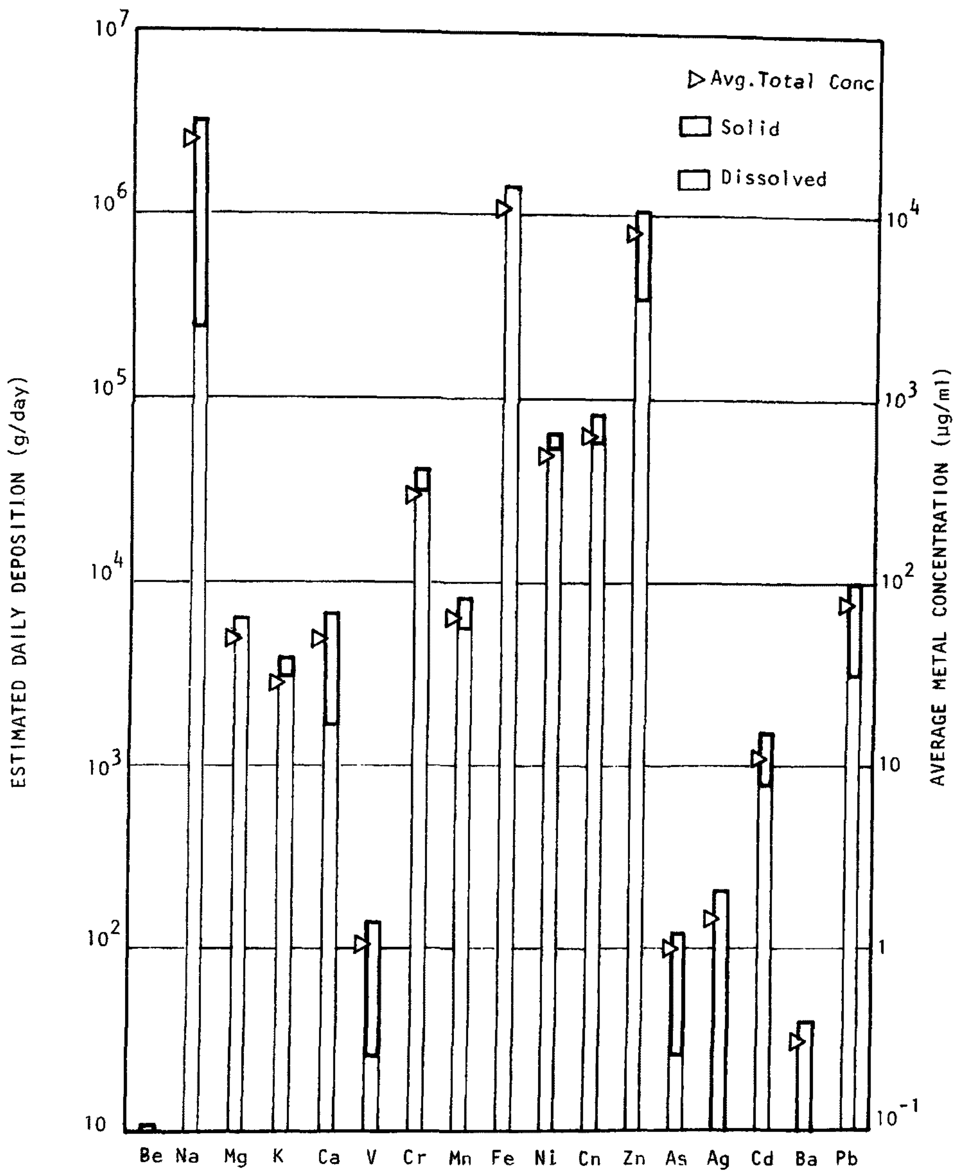


Figure A-4 Average concentration and estimated daily depositions of selected metals in hazardous wastes at the Pacific Ocean Disposal Sanitary Landfill

PERCENTAGE OF METALS DETECTED IN THE SOLUBLE PHASE OF HAZARDOUS WASTES

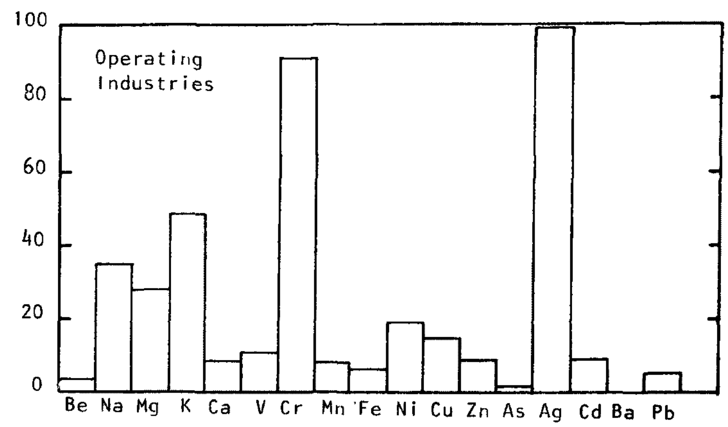


Figure A-5

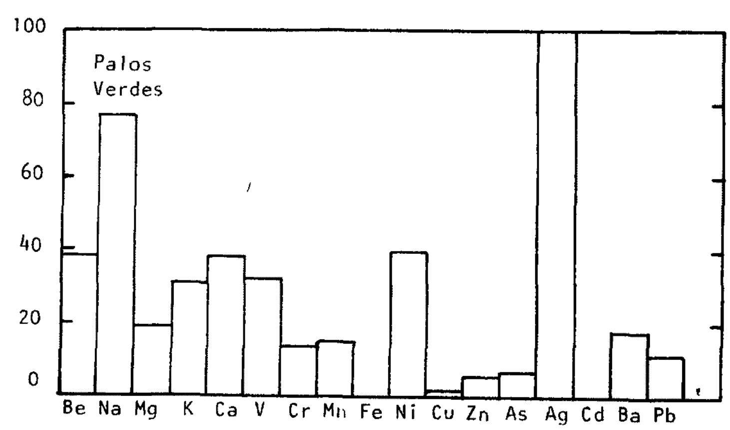


Figure A-6

PERCENTAGE OF METALS DETECTED IN THE
SOLUBLE PHASE OF HAZARDOUS WASTES

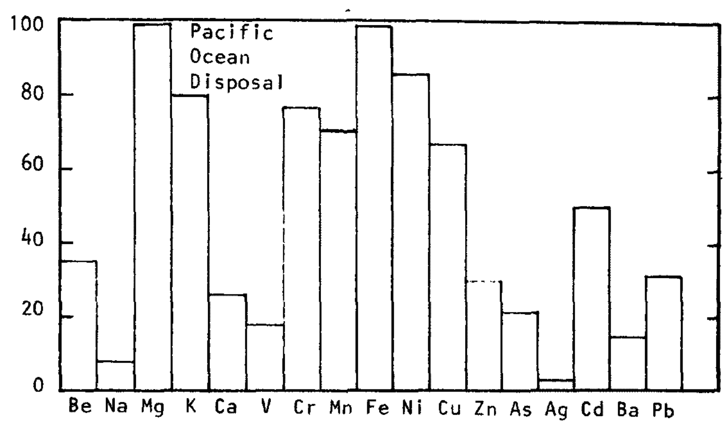


Figure A-7

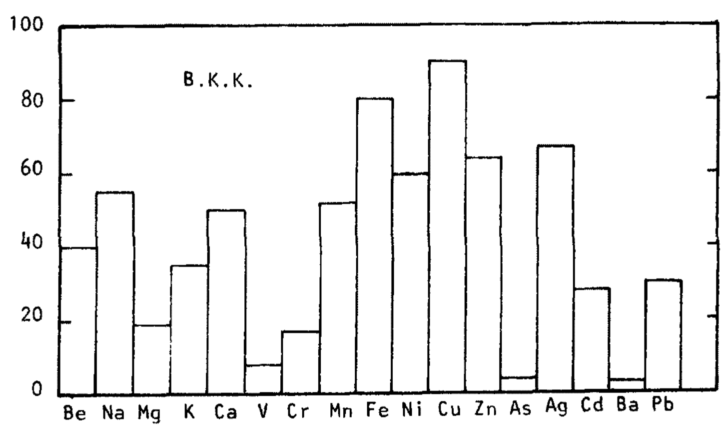


Figure A-8

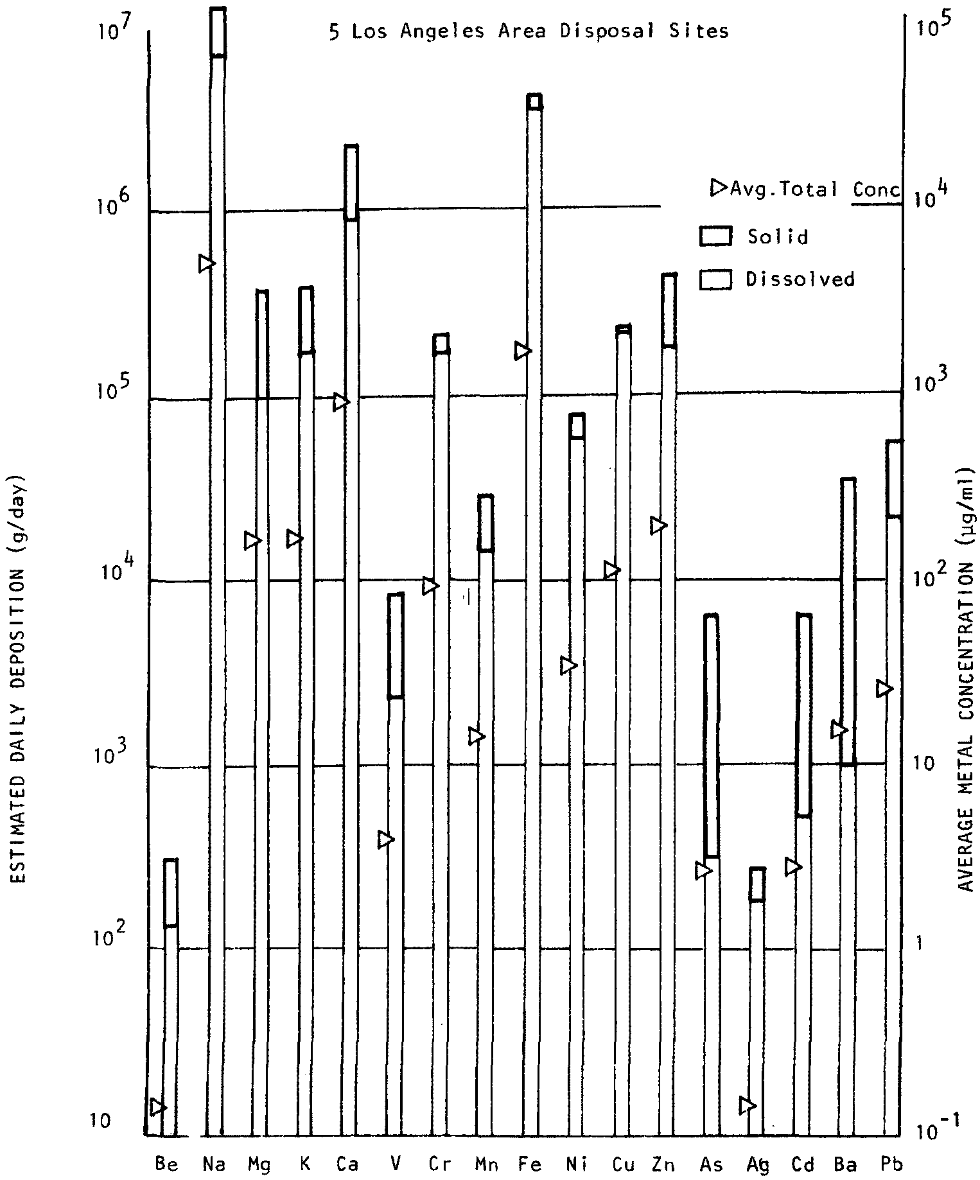


Figure A-9 Average total concentration and estimated daily depositions of selected metals in hazardous wastes.

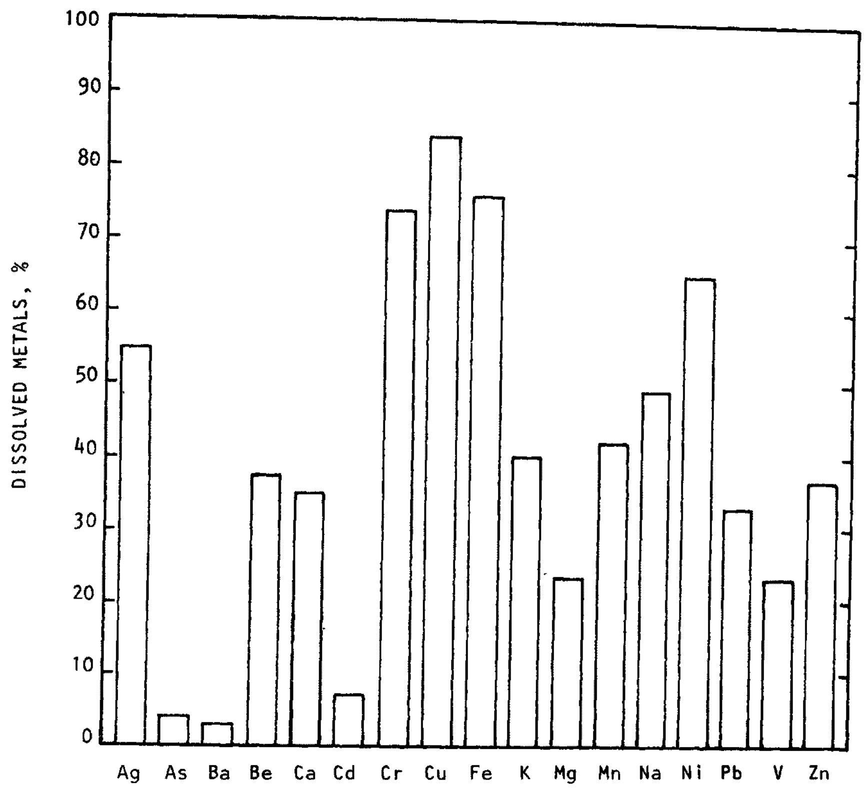
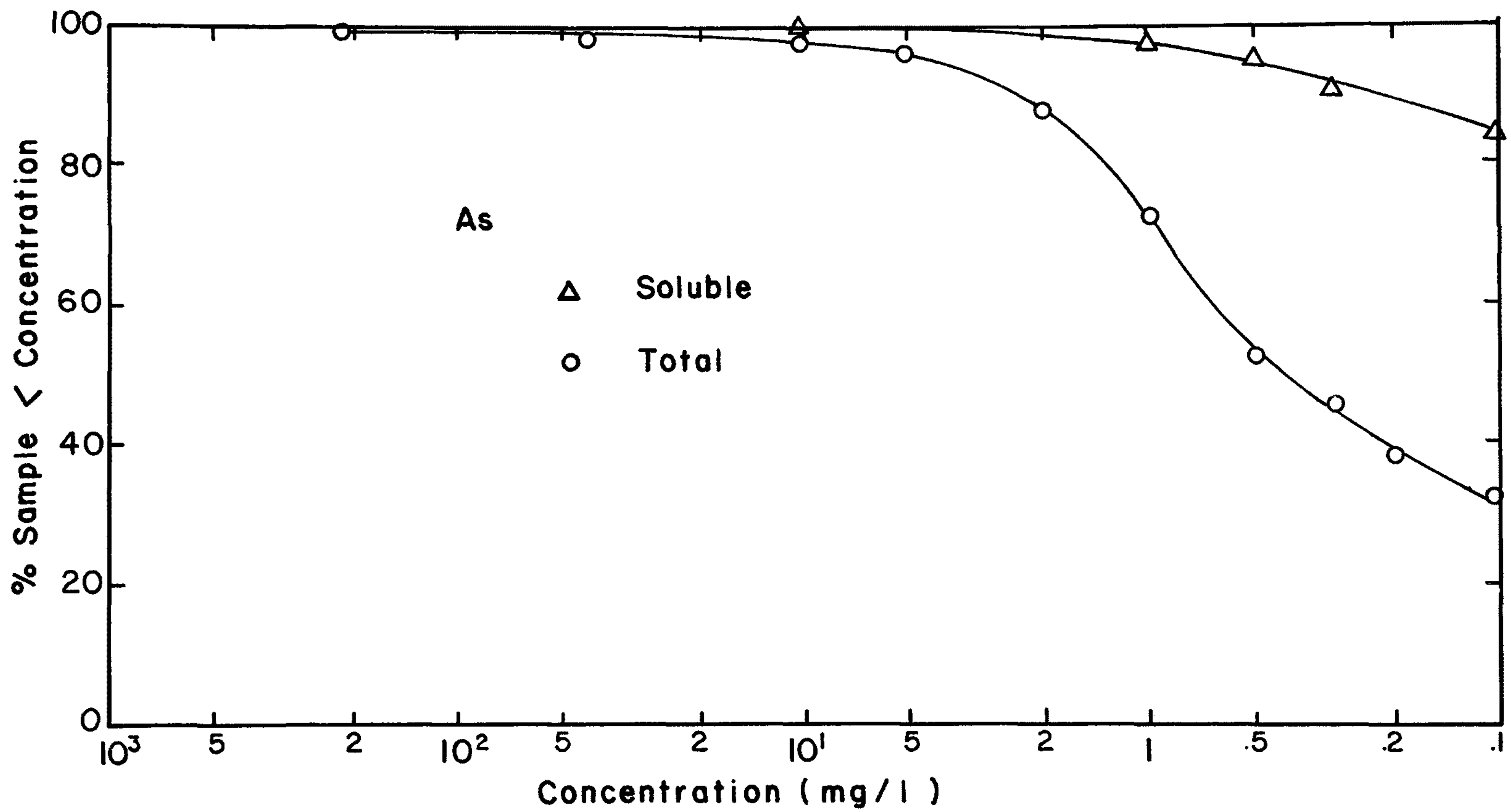
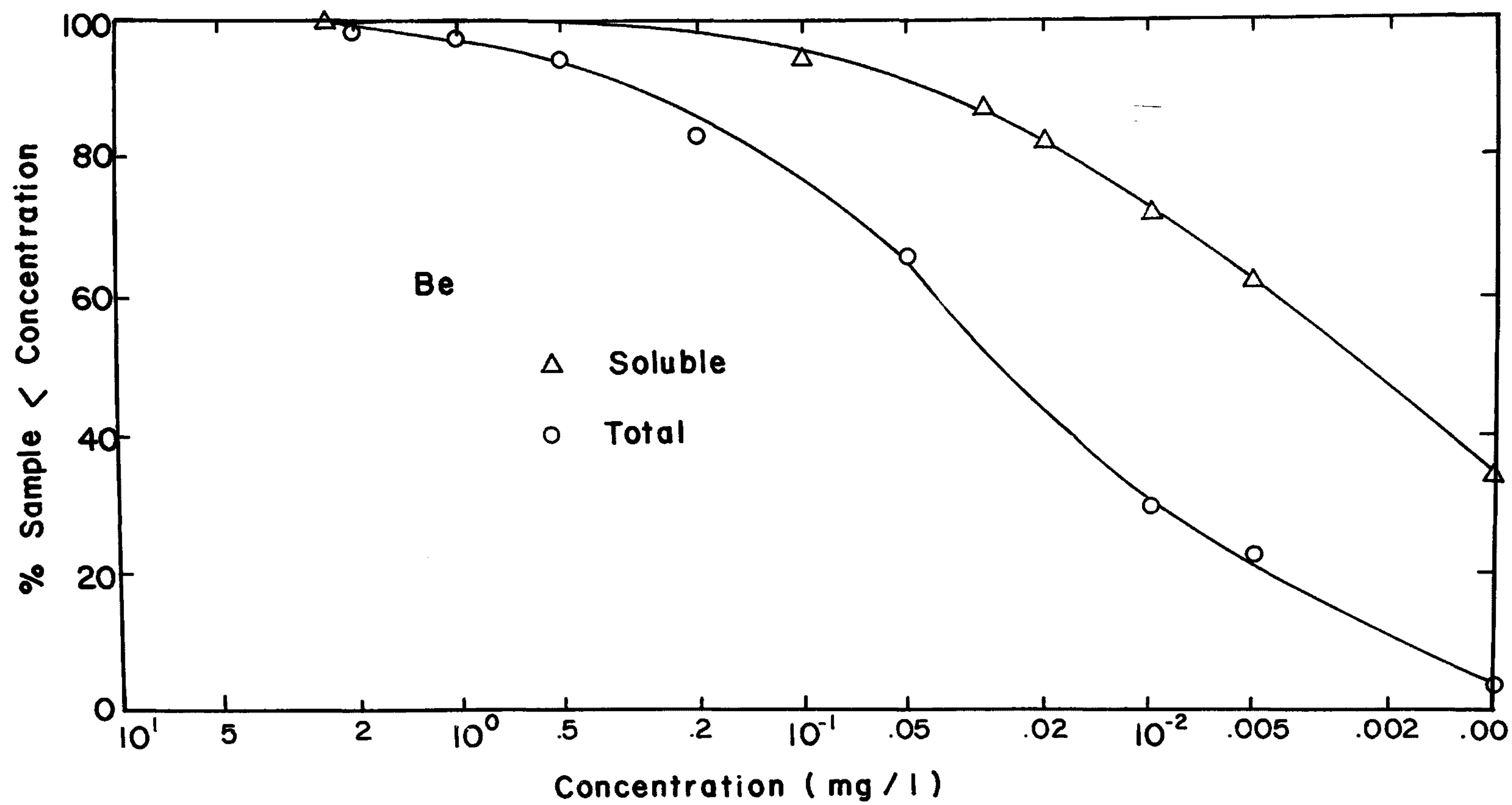


Figure A-10 Percentage of metals detected in dissolved form in hazardous wastes. These values represent the weighted averages of 5 Los Angeles area disposal sites.



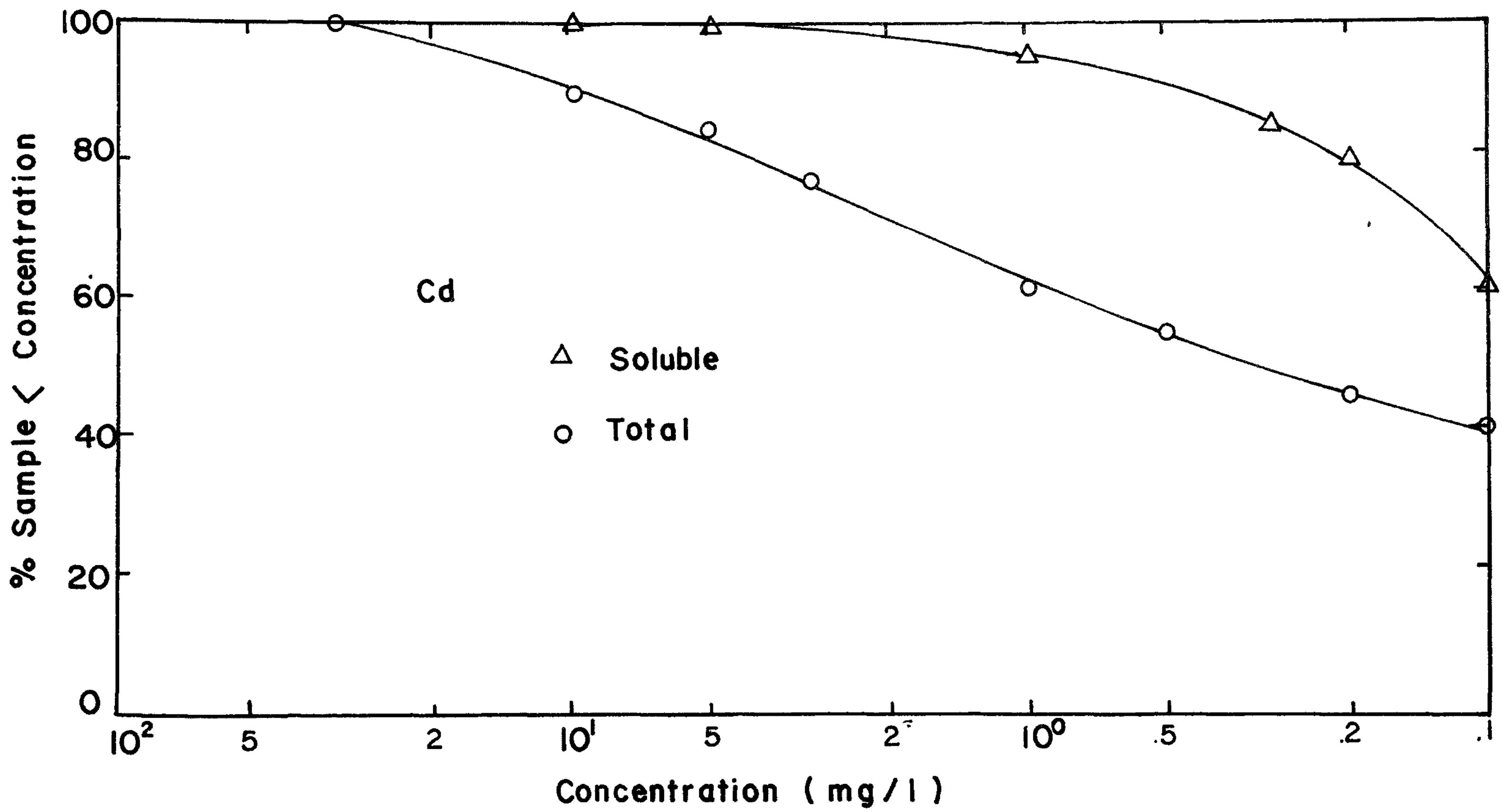
Arsenic

Figure A-11 Sample Concentration Distribution



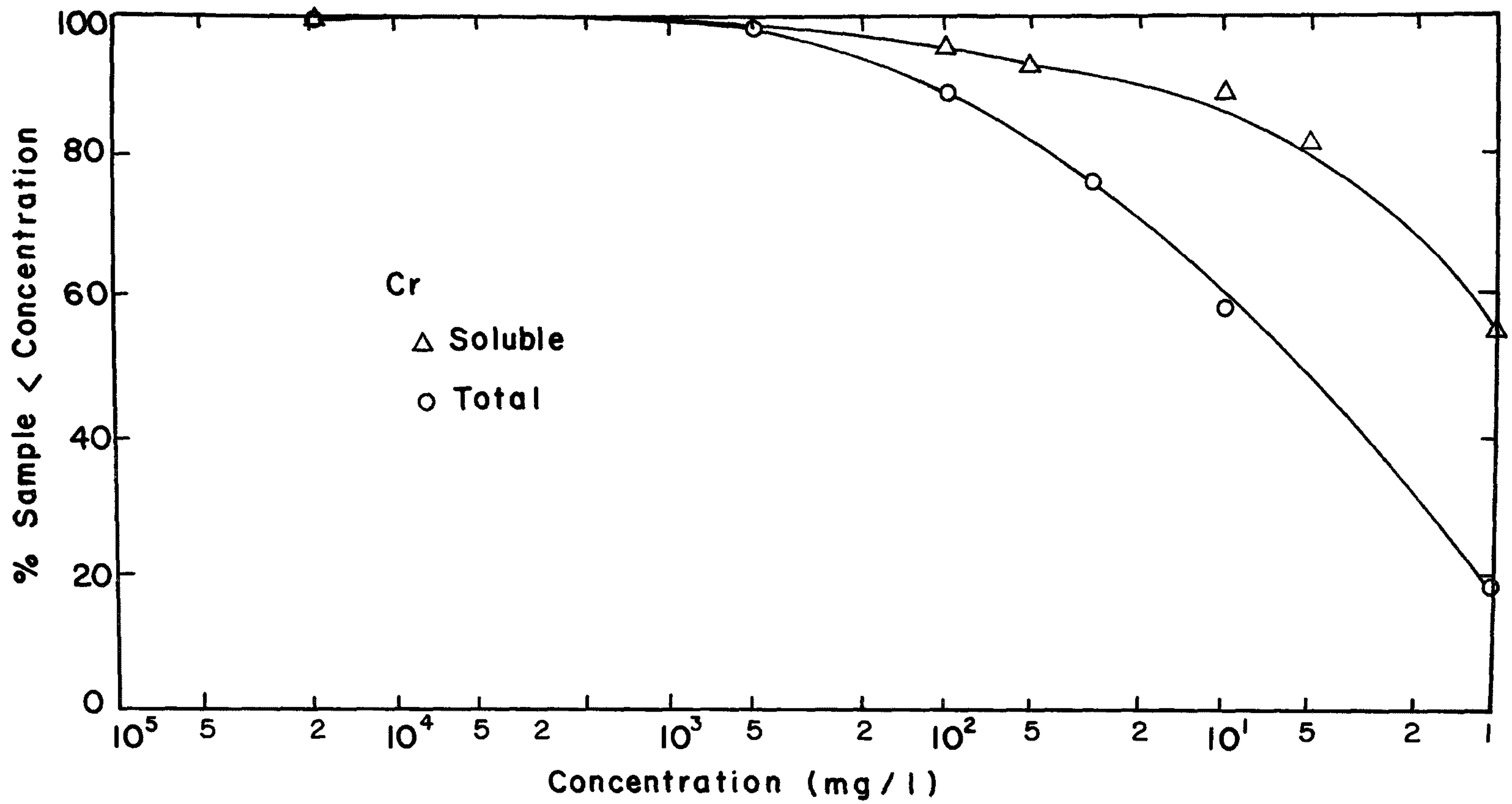
Beryllium

Figure A-12 Sample Concentration Distribution



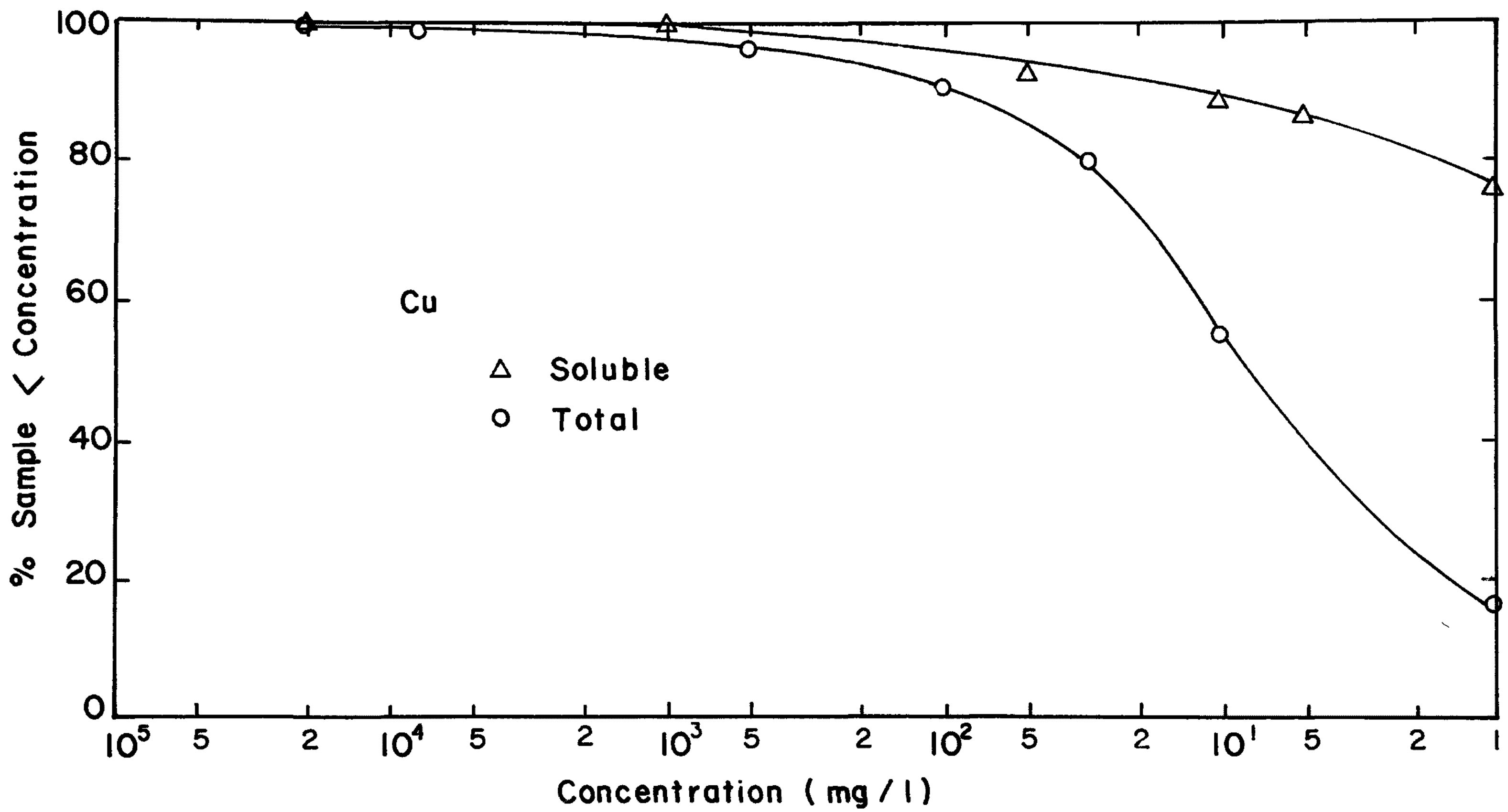
Cadmium

Figure A-13 Sample Concentration Distribution



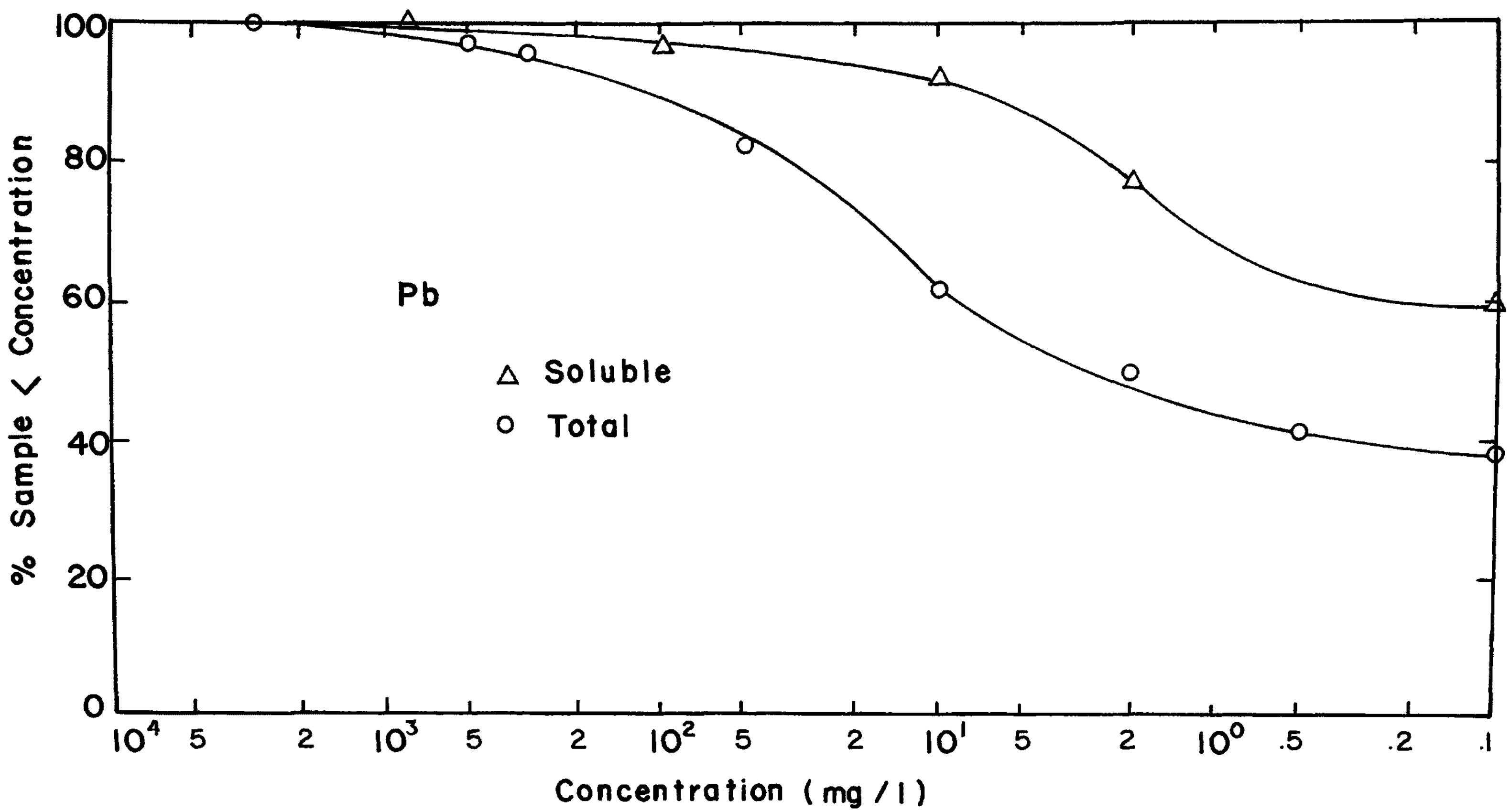
Chromium

Figure A-14 Sample Concentration Distribution



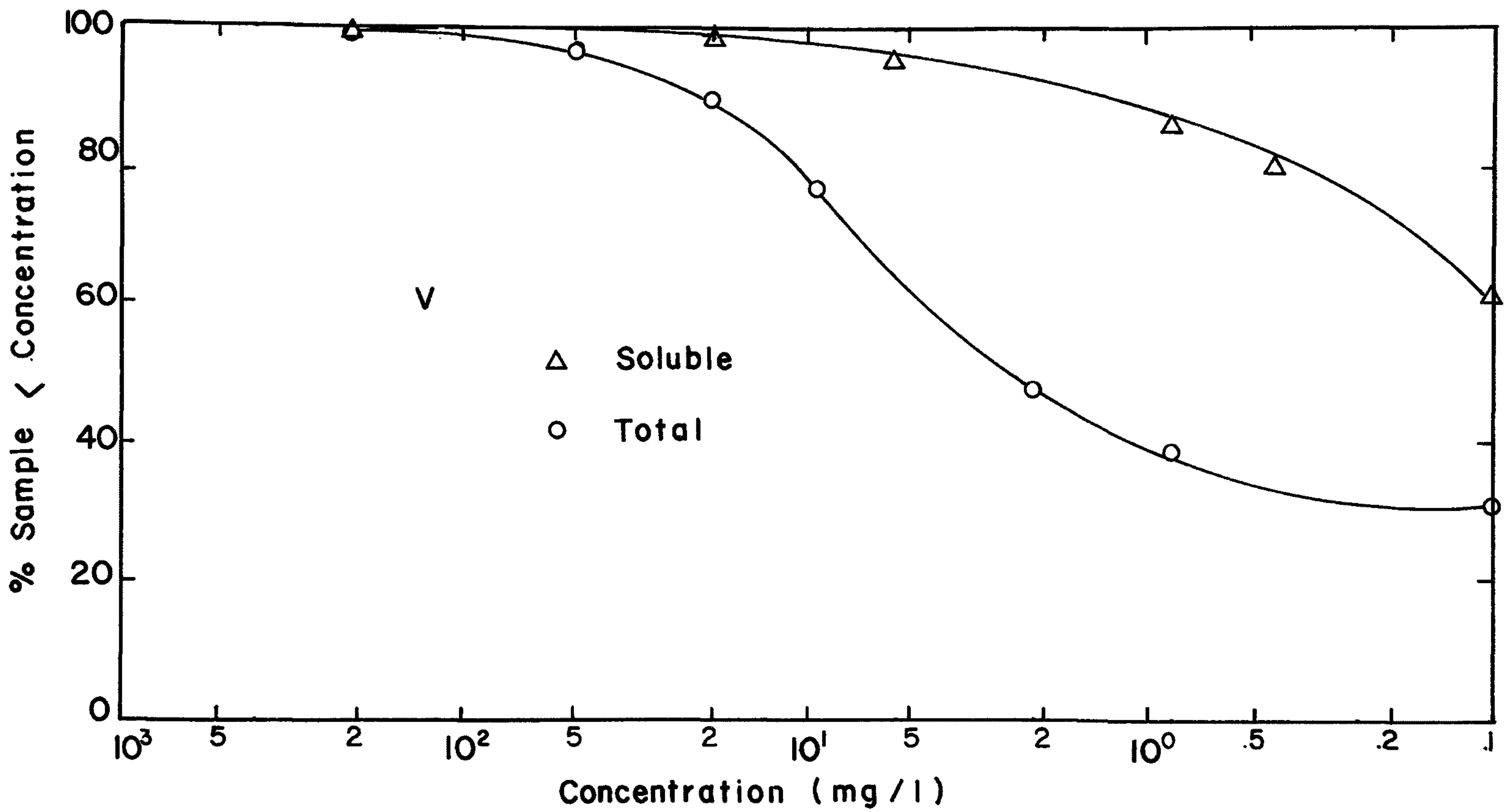
Copper

Figure A-15 Sample Concentration Distribution



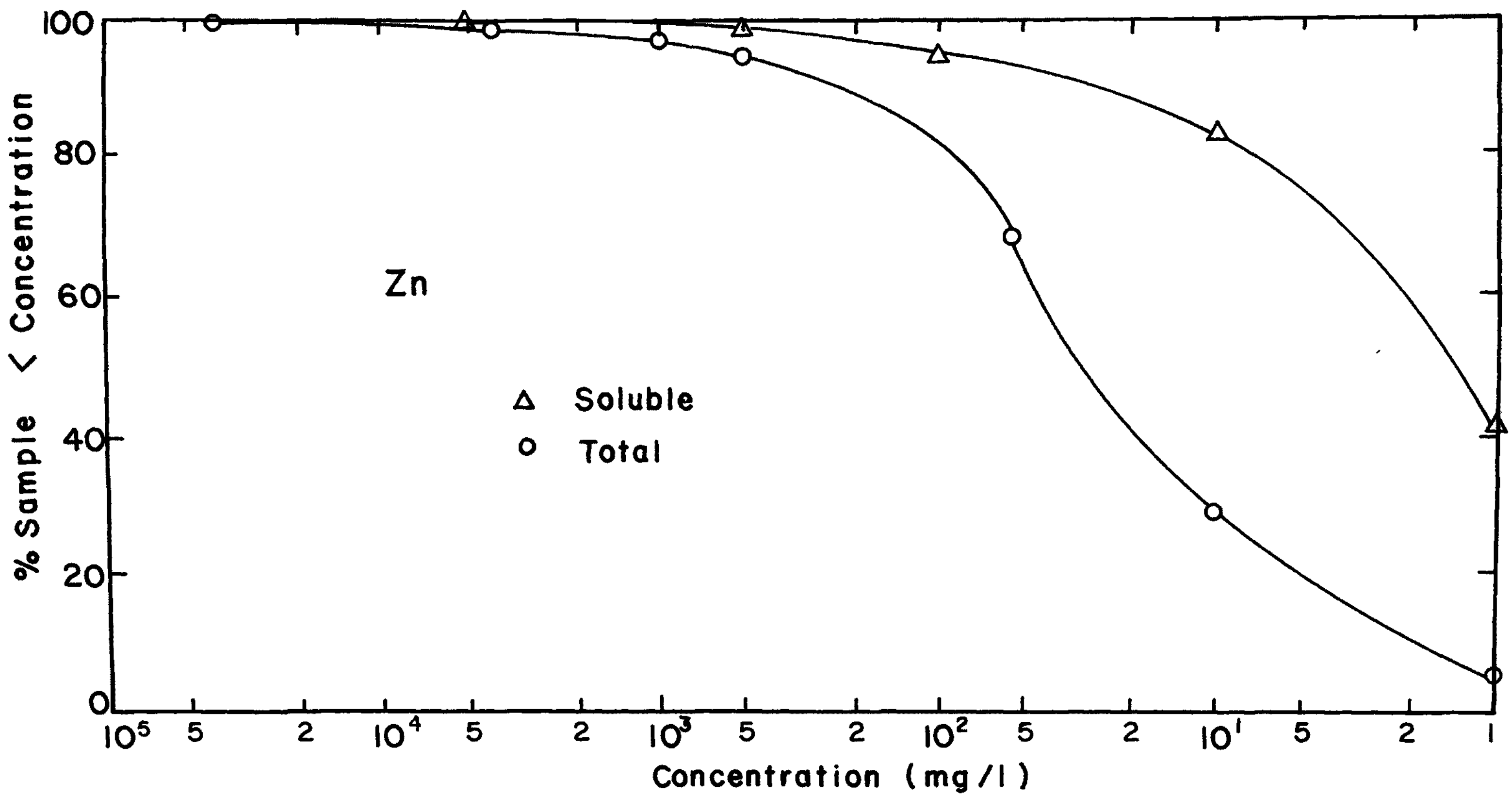
Lead

Figure A-16 Sample Concentration Distribution



Vanadium

Figure A-17 Sample Concentration Distribution



Zinc

Figure A-18 Sample Concentration Distribution

APPENDIX B

HYDROGEOLOGIC DESCRIPTION OF CLASS I SITES

B.K.K.[32]

The B.K.K. site is located in the southerly portion of the city of West Covina, California in the San Jose Hills area. Access to the property is from the east side of Azusa Ave., approximately three miles north of the Pomona Freeway and two miles south of the San Bernadino Freeway. Azusa Ave., being a major north-south connecting link between the two freeways, provides convenient access and allows the site to serve as a tributary area of approximately 55 square miles. The property consists mainly of a large box canyon running a general east-west direction. Underdeveloped hills to the north and east provide buffer for the disposal operation. To the south of the site a new housing tract provides dwelling units for approximately 17,000 persons. The landfill site has a total of 583 acres, among which a little over 100 acres are Class I. The remaining section is designated as Class II. The Class I site is currently receiving industrial wastes prohibited from other means of discharge from 176 companies in Los Angeles County. For the month of September (1975) alone, more than 5 million gallons of semi-liquid industrial wastes were received (a total of 1052 truck loads). At the current rate, the landfill is expected to last 20 to 25 years.

The site is underlain mainly by shale and siltstone of Puente formation with lesser amounts of well-cemented sandstone, conglomerate soil, alluvium, slope wash and landslide materials. The Puente formation principally consists of highly-folded shale with local fine-grained sandstone interbeds. The unweathered Puente is devoid of large open fractures. However, there are numerous seeps and corresponding saturated conditions in the bedrock which indicate the presence of significant bedding plane and/or minor fracture permeability within the shale and siltstone members of the Puente formation. The fractured bedrock can transmit subsurface water of meteoric origin.

Generally the main streams draining the area flow in a southwesterly direction to Puente Creek and thence to San Jose Creek about 5 miles downstream from Azusa Avenue. Surface flow within the site is limited to ephemeral flow due solely to localized seasonal rainfall. Bedding planes evident within the streambed area indicate structural strikes toward east-west directions; although essentially nonwater bearing will convey any subsurface flow in this direction and therefore limit the amount of underflow toward the Puente Creek. The alluvial material lining the canyon floor could also transmit subsurface flow toward Puente Creek.

The geohydrologic conditions of the site have been modified to preclude subsurface flow from the Class I Area. A positive hydraulic barrier has been constructed after all soil, alluvium and highly-weathered bedrock were removed from the barrier site to expose the firm bedrock. Combination monitoring and extraction wells have been constructed across the canyon axix easterly of the center of the barrier fill.

The site lies within Main San Gabriel Hydrologic Subarea, groundwaters of which are beneficially used for municipal, industrial and agricultural water supply. Requirements for these disposal operations are necessary to protect the water quality for the beneficial uses of the receiving waters.

OPERATING INDUSTRIES (O.I.)[33]

Operating Industries, Inc., operates a solid waste disposal site at Monterey Park, California. The site is approximately 190 acres in size. It is intersected by the Pomona Freeway and is bounded on two sides by the City of Montebello.

The disposal site is underlain by the Fernando Formation of Pliocene (and possibly Pleistocene) age within the San Gabriel Valley Hydrologic Subunit. This formation is known to be comprised primarily of conglomerate, sandstone, and siltstone.

Geological reports show that under a (eastern) portion of the landfill, there is hydraulic continuity between the refuse and the forebay area of the Central Coastal groundwater basin. This hydraulic continuity is provided by relatively permeable conglomerate. Under another (western) protion of the landfill where conglomerate has been removed, the refuse directly overlies impervious siltstone. This western area can safely receive liquid wastes; the eastern area cannot.

In order to minimize possible lateral migration of leachate from the liquid disposal area in the western portion of the landfill, setbacks provide a buffer zone of Group 2 solid waste along the north, south, east, and west boundaries of the liquid waste disposal area.

Groundwaters downgradient of the site are of good quality and are extensively used for municipal, industrial, and agricultural purposes. A Southern California Gas Company Well located in close proximity to the southwest portion of the disposal sites is used for irrigation of lawns and trees on the Gas Company's property.

Gas probes have been installed around the perimeter of the landfill to detect gas migration. The leachate monitoring wells drilled into the landfill will also serve as gas extraction wells when such programs become economically feasible.

CALABASAS (C.B.)[34]

The disposal site encompasses a rectangularly shaped area of about 260 acres, located about one-half mile north of U.S. Highway 101 and one mile east of the town of Agoura between the Santa Monica Mountains to the south and the Simi Hills to the north.

The site is located near the top of an east-west ridge that attains an elevation of almost 1,500 feet above sea level. Elevations of the ground surface in the immediate vicinity range from about 900 to 1200 feet.

The site is immediately underlain by middle Miocene deposits of the Topanga Formation, with outcrops of the late Miocene Modelo Formation at the northeast margin of the site, and recent alluvium appearing along the southeast margin.

The Topanga Formation includes predominately medium-to-course grained sandstone and conglomerate with lesser amounts in interbedded shales. Interfingering, lensing and lateral gradiation of beds within this formation are common. The sandstone is generally well-cemented with low porosity and low permeability. However, there are local sandstone and conglomerate beds that are poorly cemented and can permit the storage and transmission of groundwater.

The Modelo Formation consists predominately of brittle, thin-bedded, highly fractured shales and mudstone, production of water from which is very limited.

Although the sediments of both the Topanga and Modelo Formations are highly folded and fractured, faulting is almost absent. The steep dips (30^{o}-40^{o}) of the beds restrict horizontal movements of liquids. Because of the relatively impervious nature of these materials, it is considered that wastes deposited on the site, except the small alluvial area near the S.E. corner of Sec. 24, TIN, R18W, will be essentially hydraulically isolated from the groundwaters of adjacent canyons where alluvial deposits form water-bearing strata. One water well at the site, constructed by the Sanitation Districts, penetrates conglomerate and sandstone beds of very low permeability values of 10-20 gallons per day per square foot. Groundwater levels in this well have no relation to water levels in wells located in the alluvium.

The drainage area tributary to the proposed disposal facility is about 95 acres. The main streams draining the area flow in a south-easterly direction, and converge with the Las Virgenes Creek about one mile south of the site. The Las Virgenes Creek, about three miles south, merges with the Malibu Creek and continues to the ocean some seven miles further south. A minor stream draining the north-west corner of the site follows west to Medea Creek which joins Malibu Creek upstream from the Las Virgenes confluence. There are no known direct diversions or uses made of the waters of the Las Virgenes Creek or Medea Creek in the vicinity of the subject disposal site, but waters draining from this area through the Las Virgenes-Medea-Malibu Creek system form an important source of recharge for the underlying groundwater basin.

Water is drawn from wells along these creeks for domestic and agricultural uses. The quality of these groundwaters is unsatisfactory based on the United States Public Health Service Drinking Water Standards and is Class 3 for irrigation purposes. There are no water wells within one-half mile of the disposal site.

PALOS VERDES (P.V.)[35]

The Palos Verdes disposal site is situated on the north slopes of the Palos Verdes Hills. In accordance with waste discharge requirements, portions of the site are limited to Group 2 and Group 3 waste materials and other portions may accept Group 1, Group 2, and Group 3 wastes. Filling of the Parcel 1 area was completed in February 1965 and it is now being used as an arboretum. The Class I areas of Parcels 3 and 5 have also been completed. Groups 2 and 3 wastes are currently being placed in Parcel 4. The only remaining active Class I area in Parcel 2 is expected to be filled shortly.

Because of the need for additional capacity of the disposal pf Group 1 wastes, the County Sanitation Districts of Los Angeles on March 14, 1975, requested reclassification of the unfilled portion of the landfill, including Parcel 6 for use as a Class I disposal area. The District's proposal was approved by the California REgional Water Quality Control Board in early 1976.

The Class I expansion area has been excavated to an elevation of 220 feet above sea level so that the abandoned tunnels from the past diatomite mining operations no longer exist. All sand materials on or adjacent to this area have been removed and the entire proposed Class I area is excavated to bedrock. The bedrock (predominately Malaga mudstone and Valmonite diatomite) is well-exposed in the bottom and the side of the excavation. Preparation of the area by excavation to bedrock uncovered no seeps, springs, or groundwater. The on-site bedrock permeability in test holes was low. It varied between 1×10^{-7} and 5×10^{-7} cm/sec.

A leachate collection system of subdrains is now being constructed. The system consists of a north westward-sloping longitudinal gravel and pipe drain set in a trench, with lateral gravel drains at 500-feet intervals. The bottom of the excavation has been sloped at a minimum 1% towards the drains.

The western limit of the Class I expansion area is more than 350 feet from an alluvium-bedrock contract in the canyon adjacent to Hawthorne Boulevard. This alluvium is a remnant of the alluvium which extends northerly and southerly along the bottom of the Hawthorne Canyon and terminates on the flank of the canyon. A barrier will be constructed at this end of the excavation with compacted mudstone which will be keyed into the bedrock. A combination monitoring and extraction well will be constructed in conjunction with the installation of the mudstone barrier to collect leachate from the subdrains for disposal at a legal disposal site or to recycle it within the Class I area.

Leachate monitoring and extraction wells will also be constructed from the intersection of the longitudinal and lateral subdrains up through the fill along the north face of the proposed disposal area. Deeper zone wells at a depth which would intercept the northward-dipping beds beneath the disposal area will also be installed as a part of the leachate and gas monitoring system.

The Districts utilize Group 2 wastes as an absorbent for the Group 1 liquid wastes. Disposal operations for Group 2 wastes in Parcel 6 were initiated in January 1976. A layer of Group 2 solid waste is being placed on the bottom of the excavation in areas where the subdrains are already installed. A layer of Group 2 wastes also will be placed against the north, east, and west walls of the excavation in Parcel 6 prior to disposal of liquid wastes at these forking faces.

Gas probes and extractor wells are proposed to control gas migration. A gas migration prevention and recovery system already exists in te interior refuse fill areas of the completed landfill.

Generally, the surface drainage is northwesterly. Surface flow within the site is limited to direct precipitation due to localized seasonal rainfall. Additional surface drainage facilities will be provided by the Districts for this area as a part of a master drainage plan for the entire site.

The Class I expansion area, with provision of the proposed control measures, meets the criteria contained in the California Administrative Code for reclassification as a Class I disposal site. The remaining portion of the landfill meets the criteria for a Class II disposal site.

The estimated capacity of the expanded Class I area is 10 million cubic yards. The completed landfill will be used for a golf course and other recreational purposes.

The proposed Class I disposal area is situated southerly from the water-bearing portion of the West Coast Hydrologic subarea in portions of Sections 28, 33 and 34, T4S, R14W, S.B.B.M. Groundwaters in that subarea are of good mineral quality and are extensively produced for municipal, domestic, industrial, and agricultural water supply.

PACIFIC OCEAN DISPOSAL (P.O.D.)[36]

The Pacific Ocean Disposal site in Wilmington was originally approved for the disposal of Group I liquid industrial wastes on December 11, 1963. A field inspection of the above site by staff members of the State Water Resources Control Board and Department of Health in March 1975, found that the site did not meet the requirements set forth in the newly adopted Subchapter 15 of the California Administrative Code for Class I disposal sites. The site was closed for the disposal of Group I wastes on October 15, 1976. The site is underlain by groundwaters which have been intruded by seawater and which are therefore too saline for use. A seawater intrusion barrier constructed and operated by the Los Angeles County Flood Control District prevents these groundwaters from migrating further inland into West Coast Basin aquifiers. There is, however, hydraulic continuity with waters of the Long Beach Harbor and the Pacific Ocean, and these must be protected from harmful effects of waste disposal. Nearby underground structures such as wells, pipelines, conduits, vaults, etc., must be protected from migration of acid wastes which could cause nuisance or water quality problems; for instance, by interconnection of saline and fresh aquifiers.

APPENDIX C

HAZARDOUS WASTE UNIT
SURVEILLANCE FORM

Sample No. OI 122 Lab No. ______ Sampling Date 9/12/75

Manifest No. 1411 Time 11:35

Producer Beth. Stl. Corp.

Producer's Address 3300 E. Slauson Ave., Vernon

Hauler Capri Pumping Service

Hauler's Address 3128 Whittier Blvd., Los Angeles

Process Type Steelmaking Waste Type Mud and Water

Chemical Components	Concentration upper	Concentration lower	Volume	(Units)
EE-203	85%	60%		
AL 203	5%	2%		
Grease	5%	2%		
SIO-2	2%	1%		

Brief Physical Description Black Liquid

APPENDIX D

SAMPLE ANALYSIS OF SELECTED METAL SPECIES

TOTAL D-1 01 (TOTAL CONCENTRATIONS, mg/l)

Ag		As		Ba		Be		Ca		Cd	
71*	0.1**	55	2.0	36	610	21	0.53	56	24,000	107	15
17	--	56	1.6	20	140	20	0.36	21	15,000	29	9.8
19	--	21	1.2	104	20	121	0.319	36	7,100	17	6
20	--	59	1.1	57	13	55	0.06	55	4,600	19	4.1
21	--	58	1.0	87	9.8	87	0.054	59	3,100	37	3.9
22	--	20	0.96	103	9.2	39	0.04	117	2,100	22	2.8
24	--	71	0.96	33	9	71	0.038	121	2,000	83	2
27	--	43	0.93	59	8.8	43	0.03	65	1,500	121	2
29	--	24	0.86	55	8.4	91	0.029	20	1,400	64	1.9
33	--	83	0.7	105	8.1	19	0.02	71	1,400	57	1.8
36	--	17	0.6	117	7.8	36	0.02	57	900	59	1.8
37	--	80	0.6	21	7.7	57	0.02	83	800	74	1.5
39	--	87	0.6	19	5.1	24	0.019	19	580	65	1
42	--	105	0.56	83	4.9	59	0.019	24	470	71	1
43	--	33	0.5	71	4.9	74	0.018	80	470	108	1
55	--	64	0.4	67	4.6	33	0.014	104	440	105	0.9
56	--	117	0.4	65	4.6	56	0.014	39	430	36	0.7
57	--	74	0.3	24	4.4	103	0.013	78	420	87	0.3
58	--	39	0.28	121	4.4	117	0.012	37	390	20	0.24
59	--	65	0.2	91	4.4	65	0.011	43	250	60	0.2
60	--	67	0.2	43	4.3	37	0.01	91	290	91	0.2
64	--	91	0.2	17	3.9	42	0.01	111	240	117	0.1
65	--	104	0.2	39	3.8	83	0.01	58	190	21	--
67	--	121	0.2	42	3.4	108	0.01	103	180	24	--
74	--	19	0.1	107	3.2	67	0.009	64	170	27	--
78	--	57	0.1	22	2.2	107	0.009	42	150	33	--
80	--	60	0.1	37	1.8	80	0.009	105	130	39	--
83	--	111	0.1	74	1.6	119	0.009	60	120	42	--
87	--	103	0.06	108	1.6	64	0.005	108	110	43	--
91	--	22	--	56	1.3	17	0.003	67	58	55	--
103	--	27	--	58	1.3	22	0.003	87	44	56	--
104	--	29	--	80	1.1	27	0.003	17	40	58	--
105	--	36	--	64	0.97	29	0.002	29	36	67	--
107	--	37	--	27	0.75	58	0.002	74	35	78	--
108	--	42	--	60	0.71	60	0.002	27	24	80	--
111	--	78	--	119	0.65	78	0.002	22	24	103	--
117	--	107	--	78	0.26	104	0.002	119	17	104	--
119	--	108	--	111	0.23	105	0.002	107	15	111	--
121	--	119	--	29	0.04	111	0.002	33	8	119	--

* Sample No.
** Total Conc. mg/l
-- Below detection limit

TABLE D-1 01 (TOTAL CONCENTRATION mg/l) - CONTINUED

Cr		Cu		Fe		K		Mg		Mn	
71	19,000	121	500	55	3,900	21	1,400	56	2,300	55	130
43	300	17	93	121	2,300	55	760	21	1,100	21	73
117	220	57	42	59	1,300	43	470	24	550	20	54
67	60	19	37	43	1,300	33	420	20	480	121	52
60	44	59	30	91	1,200	57	390	43	470	59	26
121	41	108	30	87	1,100	121	350	65	460	71	25
20	40	65	28	20	1,000	37	350	71	410	43	24
59	28	105	28	80	930	20	320	55	320	56	22
105	19	21	25	19	930	103	320	36	320	91	18
65	12	83	24	17	760	71	290	57	270	80	18
17	11	71	17	21	750	78	240	59	240	36	16
36	9.1	87	15	57	720	87	230	119	240	87	16
57	8	74	14	83	700	59	230	37	230	64	16
87	7.2	56	14	104	600	19	180	83	220	104	12
55	7	117	14	71	510	27	180	121	200	19	10
108	6.8	80	12	65	440	74	170	19	160	57	10
80	5.8	55	11	39	430	56	150	80	120	83	10
56	4	20	9.6	105	380	24	140	64	110	65	6.1
83	4	103	8.4	36	300	42	140	105	93	17	6
22	3.7	107	5.9	56	300	17	130	67	80	105	5.6
39	3.7	104	5	107	250	83	130	39	76	74	4
21	3	67	4.9	64	240	104	130	17	76	37	3.9
74	2	39	4.7	103	220	64	120	117	75	33	3.4
104	2	29	3.8	22	210	65	91	60	46	39	2.8
91	1.9	22	3.7	33	200	58	90	104	40	103	2.4
33	1.4	43	3.7	67	180	91	87	91	31	117	2
107	1.2	91	2.9	29	180	105	84	58	30	67	1.9
42	0.76	60	2.8	108	99	39	77	103	28	29	1.5
103	0.6	36	2	117	91	67	68	108	22	27	1.1
37	0.38	37	1	60	80	107	59	22	21	108	1.1
27	0.3	58	1	37	68	22	37	27	20	60	1
111	0.2	64	1	58	39	108	35	74	20	111	0.6
29	0.12	119	1	111	28	60	34	42	18	107	0.6
19	--	33	0.4	24	24	36	20	111	16	78	0.4
24	--	78	0.4	78	22	80	19	29	15	42	0.31
58	--	111	0.2	42	20	29	15	107	15	119	0.25
64	--	24	--	74	18	117	15	78	12	22	--
78	--	27	--	119	9.5	111	6.2	87	8.8	24	--
119	--	42	--	27	5	119	--	33	--	58	--

* Sample No.
** Total Conc. mg/l
-- Below Detection Limit

TABLE D-1 01 (TOTAL CONCENTRATION, mg/l) - CONTINUED

Na		Ni		Pb		V		Zn	
24	18,000	121	14	117	1,300	55	14	21	1,100
121	5,400	104	11	59	290	21	5	59	980
39	5,400	83	9	57	150	20	4.8	80	480
91	3,900	17	8.4	17	140	43	3.7	58	270
36	3,600	105	7.4	71	130	87	3.2	64	180
21	3,500	20	7.2	60	130	83	3	42	180
56	3,400	59	5.5	121	130	108	2.8	121	170
20	3,000	39	4.7	105	110	121	2	78	160
43	2,900	108	4.5	83	100	22	1.2	57	75
55	1,700	91	4.3	108	44	33	1	104	70
57	1,700	55	4	19	41	36	1	20	66
103	1,600	87	4	65	40	57	1	83	60
65	1,500	71	3.8	64	39	71	1	17	40
74	1,100	43	2.8	80	38	104	1	91	39
105	990	19	2.1	74	30	119	1	71	38
80	810	117	1.5	67	24	59	0.9	105	37
19	770	65	1.1	22	12	105	0.9	74	35
33	750	21	--	104	10	17	0.8	65	30
42	750	22	--	103	9	107	0.7	56	24
64	750	24	--	36	7.1	91	0.69	67	20
67	630	27	--	91	6.8	60	0.4	36	17
37	530	29	--	87	3	67	0.29	108	16
83	520	33	--	43	0.69	64	0.07	43	16
59	460	36	--	20	--	19	--	37	16
71	310	37	--	24	--	24	--	119	15
117	300	42	--	27	--	27	--	27	13
58	250	56	--	29	--	29	--	39	13
78	250	57	--	33	--	37	--	117	12
22	250	58	--	37	--	39	--	103	11
17	210	60	--	39	--	42	--	19	10
87	200	64	--	42	--	56	--	55	10
60	160	67	--	55	--	58	--	87	5.2
104	110	74	--	56	--	65	--	22	4.9
29	110	78	--	78	--	74	--	107	4.9
108	89	80	--	107	--	78	--	24	4.8
107	78	103	--	111	--	80	--	60	4.6
27	56	107	--	119	--	103	--	33	1
111	24	111	--			111	--	111	1
119	11	119	--			117	--	29	0.54

* Sample No.
** Total Conc. mg/l
-- Below Detection limit

TABLE D-2 BKK (TOTAL CONCENTRATION, mg/l)

Ag		As		Ba		Be		Ca		Cd	
*	**	*	**	*	**	*	**	*	**	*	**
52	2.9	27	210	59	110	52	2.4	68	13,000	39	10
99	2	64	42	97	92	39	2.1	59	8,500	33	5.8
68	1.1	35	10	19	20	69	0.95	99	7,400	70	2.9
39	1	52	9.5	81	15	29	0.89	97	6,600	80	1.7
100	0.88	29	6.6	100	11	19	0.4	71	3,400	2	1.2
80	0.67	70	3.9	99	10	97	0.32	19	2,700	50	1
19	0.34	69	2.9	52	9.5	22	0.31	49	1,600	99	1
64	0.13	97	2.8	69	7.8	59	0.28	81	1,600	98	0.63
58	0.09	104	2.8	104	7.4	70	0.21	69	1,000	42	0.5
2	--	16	2	64	7.2	80	0.2	58	360	68	0.5
3	--	106	1.4	29	6.4	99	0.15	16	280	100	0.44
8	--	75	1.3	2	6.1	104	0.15	50	270	75	0.34
15	--	19	1	68	5.4	27	0.14	27	240	58	0.33
16	--	50	1	75	5.4	100	0.13	22	190	52	0.31
17	--	42	1	3	5.1	75	0.1	42	190	19	0.22
22	--	59	1	106	5.0	106	0.075	17	180	69	0.19
23	--	71	1	63	4.8	16	0.07	15	160	64	0.13
24	--	99	1	98	4.4	68	0.063	104	130	81	0.13
27	--	15	0.9	58	3.7	42	0.052	39	120	106	0.13
29	--	81	0.9	35	3.4	17	0.05	70	110	59	0.063
33	--	24	0.8	42	3.4	50	0.049	75	100	49	0.04
34	--	80	0.7	16	2.7	15	0.04	24	96	3	--
35	--	2	0.6	27	2.5	24	0.036	78	71	8	--
42	--	39	0.5	91	2.2	23	0.031	8	67	15	--
49	--	78	0.5	17	2.1	8	0.03	3	66	16	--
50	--	23	0.41	39	2.1	71	0.03	63	66	17	--
59	--	68	0.38	23	2.0	2	0.02	35	60	22	--
60	--	22	0.31	22	1.6	60	0.02	80	59	23	--
63	--	63	0.26	80	1.3	63	0.02	34	46	24	--
69	--	49	0.23	50	1.3	64	0.02	52	45	27	--
70	--	58	0.18	78	1.3	91	0.02	91	45	29	--
71	--	98	0.03	15	1.2	49	0.019	23	39	34	--
75	--	3	--	60	1.2	58	0.017	64	30	35	--
78	--	8	--	8	1.0	34	0.013	96	20	60	--
81	--	17	--	71	1.0	78	0.006	100	16	63	--
91	--	33	--	70	0.86	81	0.005	60	15	71	--
96	--	34	--	33	0.74	33	0.003	98	14	78	--
97	--	60	--	49	0.72	35	0.003	29	9.6	91	--
98	--	91	--	34	0.21	98	0.003	106	4.4	96	--
104	--	96	--	24	0.19	96	0.002	2	--	97	--
106	--	100	--	96	0.1	2	--	33	--	104	--

* Sample No.
** Total Concentration, mg/l
-- Below detection limit

TABLE D-2 BKK (TOTAL CONCENTRATION, mg/l) - CONTINUED

Cr		Cu		Fe		K		Mg		Mn	
*	**	*	**	*	**	*	**	*	**	*	**
17	620	80	20,000	39	140,000	29	1200	59	1400	80	820
39	460	39	8100	80	140,000	68	870	99	990	39	510
27	290	17	490	27	19,000	19	820	16	740	68	80
69	160	69	430	69	4900	69	670	97	730	59	52
100	130	2	390	70	3100	104	630	68	730	97	49
29	100	27	330	52	2100	59	500	29	530	29	39
70	92	70	110	97	1300	49	460	24	400	99	33
2	88	33	44	76	960	99	440	15	390	27	23
80	74	98	43	35	600	100	440	27	320	104	23
104	47	100	37	59	590	60	370	69	270	69	20
35	40	75	27	19	540	97	340	71	270	70	18
97	40	16	27	50	440	16	230	104	240	16	13
33	29	35	24	3	440	15	210	70	210	19	10
71	29	106	21	75	390	81	170	8	160	24	10
19	20	97	19	99	370	70	170	81	160	71	10
8	19	3	13	22	330	42	140	19	150	100	8.9
99	19	42	11	42	320	50	130	42	130	15	6.5
59	13	99	10	15	270	75	100	3	88	52	6
58	11	81	7.4	81	270	80	100	50	88	33	4.8
16	10	29	6.8	17	260	24	72	17	82	81	4.7
42	9	72	5.7	71	240	71	68	52	77	3	4
106	9	8	4.8	2	230	27	58	22	67	91	4.4
96	8	50	3.9	104	230	33	58	39	66	22	2.9
50	5.9	64	3.1	100	230	8	57	75	62	50	2.9
52	5.6	59	3	33	180	78	49	100	56	2	2.3
81	5.6	96	3	29	170	34	33	49	52	75	2.1
68	4.7	24	2.9	68	140	35	32	33	48	17	2
34	4.2	91	2.8	58	140	22	30	106	46	35	2
24	3.8	52	2.6	49	120	96	29	80	35	42	2
78	2.9	63	2.6	23	110	52	29	23	26	8	1.9
22	2.8	23	2	91	110	3	20	35	25	23	0.56
91	2.8	68	1.9	8	86	17	20	78	25	64	0.56
98	2.6	49	1.2	64	70	39	20	96	20	58	0.46
75	2.1	71	1	34	62	106	19	34	16	106	0.38
23	2	58	0.28	78	59	58	16	58	16	98	0.21
64	2	60	0.063	63	40	23	15	91	14	96	0.2
60	1	15	--	24	38	2	12	2	12	34	0.1
49	0.63	19	--	106	38	64	0.31	60	11	49	--
3	--	34	--	96	20	63	--	64	10	60	--
15	--	78	--	98	18	91	--	98	6	63	--
63	--	106	--	20	11	98	--	63	--	78	--

* Sample No.
** Total Concentration, mg/l
-- Below Detection Limit

TABLE D-2 BKK (TOTAL CONCENTRATION, mg/l) - CONTINUED

Na		Ni		Pb		V		Zn	
*	**	*	**	*	**	*	**	*	**
22	35,000	39	2100	2	920	29	12	80	5100
58	26,000	17	1200	100	310	59	8	39	3000
100	18,000	80	480	69	220	104	7.4	70	150
29	15,000	69	76	75	94	99	7	100	140
70	13,000	104	219	33	64	19	7	17	92
24	9600	19	23	70	59	97	5.6	2	76
59	8600	70	15	96	35	15	4.7	15	74
27	7500	15	11	27	23	3	4.4	16	71
104	7400	29	10	80	17	16	4.1	78	69
68	6600	100	8.9	3	15	69	3.9	50	69
99	5400	64	8	97	12	64	3	75	68
71	4900	99	7.5	16	10	49	2.9	3	68
15	4800	106	7	17	10	63	2.6	33	62
16	4600	68	6.6	39	10	52	2.6	42	60
75	3800	97	6.6	64	10	39	2	19	58
97	3800	91	6.5	52	8	68	1.9	68	52
42	3700	16	6.1	50	5	106	1.9	63	33
50	3300	3	6	98	5	80	1.7	27	28
23	3100	27	5.8	68	3.1	100	1.4	8	21
17	2600	59	5.7	34	3	27	1.2	52	21
78	2500	42	5	22	2	23	1	29	19
34	1400	58	4.9	99	2	24	1	99	18
19	1300	22	4.8	58	1.4	35	1	35	16
8	1200	49	4.6	104	1.3	70	1	71	16
106	780	50	3.9	106	1.3	71	1	59	16
81	720	24	3.8	19	1.2	81	0.9	64	15
69	640	52	3	59	0.63	58	0.28	97	13
39	590	96	3	8	--	75	0.21	34	11
60	530	33	2.9	15	--	22	0.19	96	11
52	390	71	2.9	23	--	60	0.03	104	10
35	330	63	2.6	24	--	2	--	24	9.6
91	260	75	2.1	29	--	8	--	81	9.3
33	190	8	1.9	35	--	17	--	69	9.8
49	150	35	1	42	--	33	--	106	7.5
98	140	81	0.9	49	--	34	--	91	6.5
80	130	98	0.9	60	--	42	--	58	5.3
63	92	2	--	63	--	50	--	23	5.1
96	88	23	--	71	--	78	--	22	4.8
64	50	34	--	78	--	91	--	98	2.4
2	41	60	--	81	--	96	--	49	1.1
3	20	78	--	91	--	98	--	60	0.06

* Sample No.
** Total Concentration, mg/l
-- Below Detection Limit

TABLE D-3 PV, POD, CB (TOTAL CONCENTRATION, mg/1)

Ag		As		Ba		Be		Ca		Cd	
*	**	*	**	*	**	*	**	*	**	*	**
PV-21	0.3	PV-40	4.4	PV-37	22	PV-45	1.8	PV-40	1200	PV-12	34
-12	--	-28	1.9	-12	20	-25	0.4	-4	1000	-43	17
-19	--	-33	1.2	-40	17	-28	0.34	-37	280	-40	14
-22	--	-12	1	-22	5.5	-46	0.12	-12	60	-22	14
-25	--	-43	0.6	-25	4.8	-40	0.11	-34	52	-25	12
-28	--	-25	0.1	-28	4.7	-12	0.082	-22	46	-33	8.4
-33	--	-12	--	-45	4.6	-21	0.067	-19	32	-37	8.2
-34	--	-19	--	-19	2.9	-43	0.011	-25	30	-19	4.8
-37	--	-21	--	-21	1.9	-37	0.01	-41	29	-45	4.6
-40	--	-34	--	-33	1.9	-19	0.003	-45	28	-46	4.2
-41	--	-37	--	-46	1.8	-41	0.0014	-33	22	-41	3.9
-43	--	-41	--	-43	1.7	-22	--	-43	5.2	-34	3.7
-45	--	-45	--	-41	1.2	-33	--	-21	3.4	-28	1
-46	--	-46	--	-34	0.74	-34	--	-28	--	-21	0.5
POD-2	2.7	POD-1	1.8	POD-2	0.42	POD-1	0.2	POD-2	89	POB-1	14
-1	0.9	-2	0.9	1	0.36	-3	0.08	-3	28	-2	13
-3	0.9	-3	0.84	-3	0.19	-2	0.048	-1	23	-3	10
CB-2	0.97	CB-2	2.1			CB-2	0.058	CB-2	35	CB-2	23

* Sample No.
** Total Concentration, mg/l
-- Below Detection Limit

TABLE D-3 PV, POD, CB (TOTAL CONENTRATION, mg/l) - CONTINUED

Cr		Cu		Fe		K		Mg		Mn	
*	**	*	**	*	**	*	**	*	**	*	**
PV-33	250	PV-37	44	PV-28	1000	PV-37	410	PV-46	930	PV-34	21
-28	52	-43	34	-37	780	-28	360	-12	270	-28	21
-12	51	-12	19	-43	660	-40	290	-40	250	-12	14
-43	23	-40	13	-40	580	-12	280	-37	210	-46	13
-34	19	-33	12	-12	550	-41	230	-28	200	-40	12
-46	11	-41	11	-33	360	-43	57	-19	48	-37	10
-37	10	-22	10	-19	280	-25	32	-33	42	-43	7.9
-41	10	-28	9	-46	280	-45	26	-45	41	-19	1.9
-22	9.1	-19	8	-22	180	-22	18	-22	27	-25	1.9
-25	6.7	-25	7	-34	160	-33	18	-43	20	-45	1.7
-40	2.3	-45	6	-25	130	-46	12	-41	15	-41	0.44
-21	1.1	-21	5	-41	100	-19	9.5	-25	7.7	-21	0.19
-45	0.57	-46	4	-45	37	-21	5.6	-34	7.4	-22	--
-19	--	-34	4	-21	25	-34	5.6	-21	3.4	-33	--
POD-1	1700	POD-3	780	POD-3	20,000	POD-3	35	POD-2	76	POD-1	160
-2	190	-2	720	-2	7000	-2	31	-3	40	-2	80
-3	18	-1	80	-3	2100	-1	4.0	-1	7.3	-3	20
CB-2	58	CB-2	16	CB-2	320	CB-2	450	CB-2	30	CB-2	0.97

* Sample No.
** Total Concentration, mg/l
-- Below Detection Limit

TABLE D-3 PV, POD, CB (TOTAL CONCENTRATION, mg/l) - CONTINUED

Na		Ni		Pb		V		Zn	
*	**	*	**	*	**	*	**	*	**
PV-25	5500	PV-46	17	PV-37	200	PV-21	310	PV-33	500
-21	3800	-43	7.9	-25	9.6	-12	8.2	-45	450
-40	3700	-40	7.7	-43	1.8	-28	4.8	-37	120
-28	1500	-28	4.8	-12	1.2	-46	4.2	-12	36
-43	840	-25	4.8	-19	--	-40	3.7	-43	17
-46	690	-34	4.7	-21	--	-25	1.3	-40	13
-37	580	-12	4.1	-22	--	-33	1.2	-41	12
-34	560	-37	4.1	-28	--	-19	1	-46	11
-45	530	-41	1.9	-33	--	-37	1	-28	10
-41	370	-21	0.25	-34	--	-41	1	-22	6.4
-12	370	-19	--	-40	--	-34	0.9	-34	4.7
-22	220	-22	--	-41	--	-45	0.89	-25	3.9
-19	160	-33	--	-45	--	-43	0.14	-19	0.49
-33	100	-45	--	-46	--	-22	--	-21	0.38
POD-2	43,000	POD-1	1100	POD-2	160	POD-1	4.5	POD-2	14,000
-3	17,000	-2	850	-1	40	-2	0.9	-3	4700
-1	40	-3	5	-3	19	-3	0.33	-1	4.5
CB-2	23,000	CB-2	5.3	CB-2	940	CB-2	1.5	CB-2	101

* Sample No.
** Total Concentration, mg/l
-- Below Detection Limit

APPENDIX E

MANIFEST SUMMARY

Company Name	Industrial Type	Volume (1×10^3)
	O.I. SAMPLES	
TWA	13	16
Southern Pacific RR	9	16
Standard Oil Co.	10	32
Petri Terrazzo	16	5
Continental Can Co.	7	16
Energy Development	1	48
Los Schlitz Brew Co.	9	16
Steel Castings	9	26
ARCO	2	34
Reichold Chem	16	29
Vernon Wash Rack	13	16
Safeway (Bakery)	14	18
General Latex Corp.	6	16
American Petroleum	1	32
Blue Dolphin Pools	16	4
Chevron Chemical	4	16
Certified Grocer	14	12
Emerson & Cuming Inc.	9	4
Time-NC, Ben Moore, C & M Pumping Serv.	11	5
CCA	6	8
Key Bronner Steel	8	32
Cal State Towel	6	10
Texaco Inc.	1	8
Chrome Crawig Haft Co.	7	8
Smith Tool Co.	2	10
Pilsbury Co., General Latex	14	16
W.R. Grace, Dunn Edwards	6	16
Time D.C., Asbury Trans., Fruloss Truck Wash	13	6
U.S. Manufacturing, Ferro Precision	8	8

Company Name	Industrial Type	Volume (1×10^3)
O.I. SAMPLES - Continued		
Charles Brumins., International Paper, J.B. Mfg. Co.	9	16
Gray Truck	13	16
Pasha Trucking	13	16
Ryder Truck	13	6
Ken Air	9	16
Union Oil	2	12
Glasteel	16	6
Inland Containers	15	6
Texaco Inc.	9	16
Calif. Milk Products	9	6
B.K.K. SAMPLES		
Albert Van Lust & Co.	15	4.8
Shell Chemical	4	16
Texaco	2	112
Long Beach Oil Dev. Co.	1	96
Standard Oil	2	19
Crown Plating	7	16
Thums	1	128
Stauffer Chemical	5	16
GATX	11	16
Petrochemical Inc.	3	16
Los Angeles Chemical	4	16
Denny's Restraunt	14	16
Oil & Solvent Process Co.	6	16
Staffer Chemical	4	16
A & F Plastik	9	16
Unknown	17	16
Unknown	17	16
Mobil Oil	2	16
Van Camp Sea Foods Co.	14	16
Whitco Chemical	4	16
Montrose Chemical	5	240
Unknown	17	16
Metro Stevadore	12	16
Sunkist Growers	14	48
Stauffer Chemical	4	48
Unknown	17	16
Burroughs Inc.	7	16
Cyclone Excelweld	11	16
Petrochemical Inc.	3	73
UCA of Calif.	10	2.9
Tennet Corp.	4	16

Company Name	Industrial Type	Volume (1×10^3)
	B.K.K. SAMPLES - Continued	
CHBM Aero	17	3
Hall, Burton Services	17	16
Montrose Chemical	5	176
Edington Oil Co.	2	48
Thums	1	48
Bruce Lint Computer Transmission	7	16
Douglas Oil	1	32
Ditty Drum Co.	11	16
Basin By Products	17	16
Mobil Oil	2	16
	PALOS VERDES SAMPLES	
Union Oil Co.	2	24
Texaco Inc.	2	47
Unknown	17	16
Texaco Co.	2	122
Standard Oil	2	112
ARCO	10	16
Douglas Oil Co.	17	16
SCRTD	13	16
Unknown	11	16
Douglas Aircraft Co.	13	16
Pacific Pumps	9	6.4
Todd Shipyard	12	17.5
OBAM Inc.	2	6.4
	P.O.D. SAMPLES	
Pacific Tube Co.	7	6
PGB Industries	8	16
Atlas Galvanizing	7	19
	C.B. SAMPLE	
Pacific Coast Drum	11	21

APPENDIX F

METAL SPECIES IN CLASS I LANDFILLS

TABLE F-1 ARSENIC

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	0.42	4.7	0.57	2.1	0.99
Weighted Avg. (Sol.)**	0.009	0.36	0.044	0.5	0.25
Weighted Avg. (Solids)*	0.41	4.6	0.53	1.7	0.79
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	3.2 (1.7)	110 (4.1)	36 (6.5)	40 (17.4)	27 (21)
Solids	190 (98.3)	2.6×10^3 (95.9)	520 (93.5)	190 (82.6)	100 (79)
Total	190	2.7×10^3	560	230	130

* Total Volume
** Liquid Volume

TABLE F-2 BARLUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	42	9.2	6.0	0.85	0.30
Weighted Avg. (Sol.)**	0.28	0.55	1.3	0.45	0.055
Weighted Avg. (Solids)*	41	8.90	5.0	0.52	0.26
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 99 (0.5) 1.9×10^4 (99.5) 1.9×10^4	 150 (2.8) 5.2×10^3 (97.2) 5.4×10^3	 1.0×10^3 (17.2) 4.8×10^3 (82.8) 5.8×10^3	 36 (38.3) 58 (61.7) 94	 6.1 (15.6) 33 (84.4) 39

* Total Volume
** Liquid Volume

TABLE F-3 BERYLLIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	0.042	0.16	0.20	0.04	0.084
Weighted Avg. (Sol.)**	0.0019	0.13	0.092	0.006	0.035
Weighted Avg. (Solids)*	0.041	0.094	0.13	0.036	0.055
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	0.69 (3.5)	36 (40)	75 (38.3)	0.49 (11.2)	3.9 (35.2)
Solids	19 (96.5)	54 (60)	120 (61.7)	3.4 (88.8)	7.2 (64.8)
Total	20	90	200	4.4	11

* Total Volume

** Liquid Volume

TABLE F-4 CADMIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	1.5	0.35	11	23	12
Weighted Avg. (Sol.)**	0.19	0.20	0.10	0.3	7.0
Weighted Avg. (Solids)*	1.3	0.25	11	23	5.9
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 66 (9.5) 630 (90.5) 700	 58 (27.9) 150 (72.1) 210	 81 (0.8) 1.0×10^4 (99.2) 1.1×10^4	 24 (1.0) 2.5×10^3 (99) 2.5×10^3	 770 (50) 770 (50) 1.5×10^3

* Total Volume
** Liquid Volume

TABLE F-5 CALCIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	1500	1100	100	35	51
Weighted Avg. (Sol.)**	170	1100	46	47	16
Weighted Avg. (Solids)*	1400	530	63	0.97	38
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	6.1×10^4 (9.4)	3.1×10^5 (50)	3.7×10^4 (37.4)	3.7×10^3 (97.1)	1.8×10^3 (26.9)
Solids	6.5×10^5 (90.6)	3.1×10^5 (50)	6.2×10^4 (62.6)	110 (2.9)	4.9×10^3 (73.1)
Total	7.1×10^5	6.2×10^5	9.9×10^4	3.8×10^3	6.7×10^3

* Total Volume
** Liquid Volume

TABLE F-6 CHROMIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	280	32	20	58	320
Weighted Avg. (Sol.)**	340	12	3.5	52	290
Weighted Avg. (Solids)*	24	26	17	21	74
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	1.2×10^5 (91.6)	3.5×10^3 (18.9)	2.9×10^3 (15.3)	4.1×10^3 (64.1)	3.1×10^4 (76.4)
Solids	1.1×10^4 (8.4)	1.5×10^4 (81.1)	1.6×10^4 (84.7)	2.3×10^3 (35.4)	9.6×10^3 (23.6)
Total	1.3×10^5	1.9×10^4	1.9×10^4	6.4×10^3	4.1×10^4

* Total Volume
** Liquid Volume

TABLE F-7 COPPER

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	16	160	11	16	660
Weighted Avg. (Sol.)**	3.1	290	0.24	6.8	520
Weighted Avg. (Solids)*	13	15	10	11	220
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 1.1×10^3 (15.4) 6.2×10^3 (84.6) 7.3×10^3	 8.3×10^4 (90.4) 8.9×10^3 (9.6) 9.2×10^4	 190 (1.9) 1.0×10^4 (98.1) 1.0×10^4	 540 (31) 1.2×10^3 (69) 1.7×10^3	 5.7×10^4 (67.1) 2.8×10^4 (32.9) 8.5×10^4

* Total Volume
** Liquid Volume

TABLE F-8 IRON

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	460	2500	260	320	11,000
Weighted Avg. (Sol.)**	45	4000	2.1	0.8	13,000
Weighted Avg. (Solids)*	430	500	260	320	7.5
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 1.6×10^4 (7.4) 2.0×10^5 (92.6) 2.2×10^5	 1.2×10^6 (80.5) 2.9×10^5 (19.5) 1.5×10^6	 1.7×10^3 (0.7) 2.6×10^5 (99.3) 2.6×10^5	 64 (0.2) 3.5×10^4 (99.8) 3.5×10^4	 1.5×10^6 (99.9) 970 (0.1) 1.5×10^6

* Total Volume

** Liquid Volume

TABLE F-9 LEAD

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	36	13	9.7	930	77
Weighted Avg. (Sol.)**	2.8	7.9	1.4	840	28
Weighted Avg. (Solids)*	34	9.3	8.5	340	54
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 1.0×10^3 (5.9) 1.6×10^4 (94.1) 1.7×10^4	 2.3×10^3 (29.9) 5.4×10^3 (70.1) 7.7×10^3	 1.1×10^3 (12.2) 8.3×10^3 (87.8) 9.4×10^3	 6.7×10^4 (64.4) 3.7×10^4 (35.6) 1.0×10^5	 3.1×10^3 (30.7) 7.0×10^3 (69.3) 1.0×10^4

* Total Volume
** Liquid Volume

TABLE F-10 MAGNESIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	250	180	71	30	50
Weighted Avg. (Sol.)**	91	69	16	42	59
Weighted Avg. (Solids)*	180	140	57	0	0.20
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 3.3×10^4 (27.5) 8.6×10^4 (72.5) 1.2×10^5	 2.0×10^4 (19.4) 8.3×10^4 (80.6) 1.0×10^5	 1.3×10^4 (18.8) 5.6×10^4 (81.2) 6.9×10^4	 3×10^3 (100) 0 3×10^3	 6.4×10^3 (99.6) 26 (0.4) 6.4×10^3

* Total Volume
** Liquid Volume

TABLE F-11 MANGANESE

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	12	16	4.2	0.97	63
Weighted Avg. (Sol.)**	1.3	17	0.77	0.80	52
Weighted Avg. (Solids)*	11	7.6	3.6	0.39	19
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^5	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	470 (8.1)	4.8×10^3 (52.2)	6.3×10^2 (15.3)	64 (59.8)	5.7×10^3 (69.5)
Solids	5.3×10^3 (91.9)	4.4×10^3 (47.8)	3.5×10^3 (84.7)	43 (40.2)	2.5×10^3 (30.5)
Total	5.8×10^3	9.2×10^3	4.1×10^3	110	8.2×10^3

* Total Volume
** Liquid Volume

TABLE F-12 NICKEL

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	2.0	47	2.7	5.3	490
Weighted Avg. (Sol.)**	0.52	56	1.3	6.0	500
Weighted Avg. (Solids)*	1.6	19	1.6	0.97	66
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^3	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	190 (20)	1.6×10^4 (59.3)	1.0×10^3 (38.5)	480 (81.4)	5.5×10^4 (86.5)
Solids	760 (80)	1.1×10^4 (40.7)	1.6×10^3 (61.5)	110 (18.6)	8.6×10^3 (13.5)
Total	950	2.7×10^4	2.6×10^3	590	6.4×10^4

* Total Volume

** Liquid Volume

TABLE F-13 POTASSIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	190	200	79	450	29
Weighted Avg. (Sol.)**	130	140	30	600	28
Weighted Avg. (Solids)*	98	130	54	15	6.0
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^3	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	4.5×10^4 (49.5)	4.0×10^4 (35.1)	2.4×10^4 (31.2)	4.8×10^4 (96.8)	3.0×10^3 (79.6)
Solids	4.6×10^4 (50.5)	7.4×10^4 (64.9)	5.3×10^4 (68.8)	1.6×10^3 (3.2)	770 (20.4)
Total	9.1×10^4	1.1×10^5	7.7×10^4	5.0×10^4	3.8×10^3

* Total Volume
** Liquid Volume

TABLE F-14 SILVER

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	0.013	0.16	0.011	0.96	1.6
Weighted Avg. (Sol.)**	0.017	0.22	0.013	1.1	0.056
Weighted Avg. (Solids)*	--	0.053	--	0.17	1.6
Total Vol. Sampled $l \times 10^3$	587	1397	438	21	41
Est. Daily Flow $l \times 10^3$	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	0.61(100)	64(66.7)	10.7(100)	88(82.2)	6.2(3.0)
Solids	-- (0)	32(33.3)	-- (0)	19(17.8)	200(97.0)
Total	0.61	96	10.7	110	210

* Total Volume

** Liquid Volume

TABLE F-15 SODIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	2800	7000	1800	23,000	25,000
Weighted Avg. (Sol.)**	1300	7700	1600	2000	2300
Weighted Avg. (Solids)*	1800	3100	410	22,000	23,000
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^3	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total Soluble Solids Total	 4.6×10^5 (34.6) 8.6×10^5 (65.4) 1.3×10^6	 2.2×10^6 (55) 1.8×10^6 (45) 4.0×10^6	 1.3×10^6 (76.5) 4.0×10^5 (23.5) 1.7×10^6	 1.6×10^5 (6.3) 2.4×10^6 (93.7) 2.6×10^6	 2.5×10^5 (7.7) 3.0×10^6 (92.3) 3.3×10^6

* Total Volume

** Liquid Volume

TABLE F-16 VANADIUM

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples Total (Sol. + Solids) Soluble Solids	 39 38 38	 41 31 31	 14 12 12	 1 1 1	 3 3 3
Weighted Avg. (Total)*	1.1	2.3	13	1.5	1.1
Weighted Avg. (Sol.)**	0.15	0.35	5.1	0.40	0.25
Weighted Avg. (Solids)*	0.45	2.1	8.5	1.2	0.93
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^3	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day; % of Total Soluble Solids Total	 55(10.9) 450(89.1) 510	 100(7.7) 1.2×10^3(92) 1.3×10^3	 4.1×10^3(33.3) 8.2×10^3(66.7) 1.2×10^4	 32(20) 130(80) 160	 28(18.9) 120(81.1) 150

* Total Volume

** Liquid Volume

TABLE F-17 ZINC

INPUT IN CLASS I LANDFILLS

Landfill Site	O.I.	B.K.K.	P.V.	C.B.	P.O.D.
No. of Samples					
Total (Sol. + Solids)	39	41	14	1	3
Soluble	38	31	12	1	3
Solids	38	31	12	1	3
Weighted Avg. (Total)*	70	73	47	100	7800
Weighted Avg. (Sol.)**	7.9	95	3.1	100	3100
Weighted Avg. (Solids)*	64	26	45	28	3500
Total Vol. Sampled 1×10^3	587	1397	438	21	41
Est. Daily Flow 1×10^3	4.7	5.8	9.7	1.1	1.3
Est. Daily Input gm/day, % of total					
Soluble	2.9×10^3 (8.8)	2.8×10^4 (65.1)	2.5×10^3 (5.5)	8.1×10^3 (72.3)	3.4×10^5 (34.0)
Solids	3.0×10^4 (91.2)	1.5×10^4 (34.9)	4.3×10^4 (94.5)	3.1×10^3 (27.7)	4.6×10^5 (66.0)
Total	3.3×10^4	4.3×10^4	4.6×10^4	1.1×10^4	1.0×10^6

* Total Volume
** Liquid Volume

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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15. SUPPLEMENTARY NOTES

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16. ABSTRACT

This study documents the average concentration, estimated daily deposition, and partitioning of 17 metal species in hazardous wastes discharged to five Class I landfill sites in the greater Los Angeles area. These sites receive a combined estimated daily volume of 2.3 x 10^6 l/day of hazardous wastes. A total of 320 samples were collected and consolidated into 99 samples representative of 17 industry types. The data was summarized for six general industry groups: petroleum, chemical, metal, foods, industrial cleaning, and miscellaneous/unknown.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Chemical analysis Volume Separation	Class I landfills Hazardous wastes Heavy metal analysis Deposition rates	68C

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