EXECUTIVE SUMMARY

SANTA CLARA VALLEY

INTEGRATED ENVIRONMENTAL MANAGEMENT PROJECT

- REVISED STAGE ONE REPORT -

MAY 30, 1986

Office of Policy Analysis
Office of Policy, Planning and Evaluation
Environmental Protection Agency
Washington, DC 20460

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REVISED STAGE I REPORT

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Lynn Briody, City of Sunnyvale
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Patrick Ferraro, Santa Clara Valley Water District
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SANTA CLARA VALLEY
INTEGRATED ENVIRONMENTAL MANAGEMENT PROJECT:
STAGE ONE REPORT

This report presents the results of the first phase of the Santa Clara Valley Integrated Environmental Management Project (IEMP), an innovative project designed to address the environmental and public health problems posed by toxic chemicals in California's Santa Clara Valley. The IEMP, sponsored by the U.S. Environmental Protection Agency, is an effort to improve public health protection and environmental management by applying the best scientific knowledge and management skills available to the problems found in the Santa Clara Valley. The project's goals are:

- to evaluate and compare the health risks - of cancer and other chronic, toxic effects - from toxic pollutants in the environment;
- to use this evaluation to set priorities for further analysis and possible control;
- to work closely with government agencies and the community to manage environmental public health problems.

Traditionally, EPA has developed regulations aimed at controlling the health and environmental effects of a single industry, or a single pollutant in a single environmental medium (such as air or water). While substantial environmental improvement has been achieved with this approach, some drawbacks have also become apparent: often pollution controls merely shift the problem from one medium to another; little attention is paid to whether Agency programs, taken as a whole, reduce health risks in the most efficient or cost-effective way; and rarely do national standards account for the site-specific nature of a problem.

In contrast, the integrated environmental management approach takes account of the transfer of toxics across media - in land, air, surface water, and groundwater. In addition, the integrated approach is founded on the concepts of risk assessment and risk management in which estimates of risk to public health are used as a common currency for comparing a variety of pollution problems. Finally, by focusing on one community, in this case the Santa Clara Valley, the approach can assist communities in developing environmental management strategies tailored to their unique problems and characteristics.

Integrated environmental management is intended to be a practical tool for controlling pollution that threatens public health. EPA, in partnership with state and local leaders, can use estimates of the public health impacts of a wide range of environmental problems to compare those problems and set priorities for risk management. Setting priorities provides a way of working through an environmental agenda by targeting the worst problems first in order to get the most risk reduction (and thus public health benefit) for any given level of resources.

The Santa Clara Valley IEMP

The Santa Clara Valley IEMP is one of EPA's early efforts to gain field experience with this alternative approach. Similar integrated environmental management projects have analyzed the health risks from environmental toxic chemicals in Philadelphia and Baltimore.

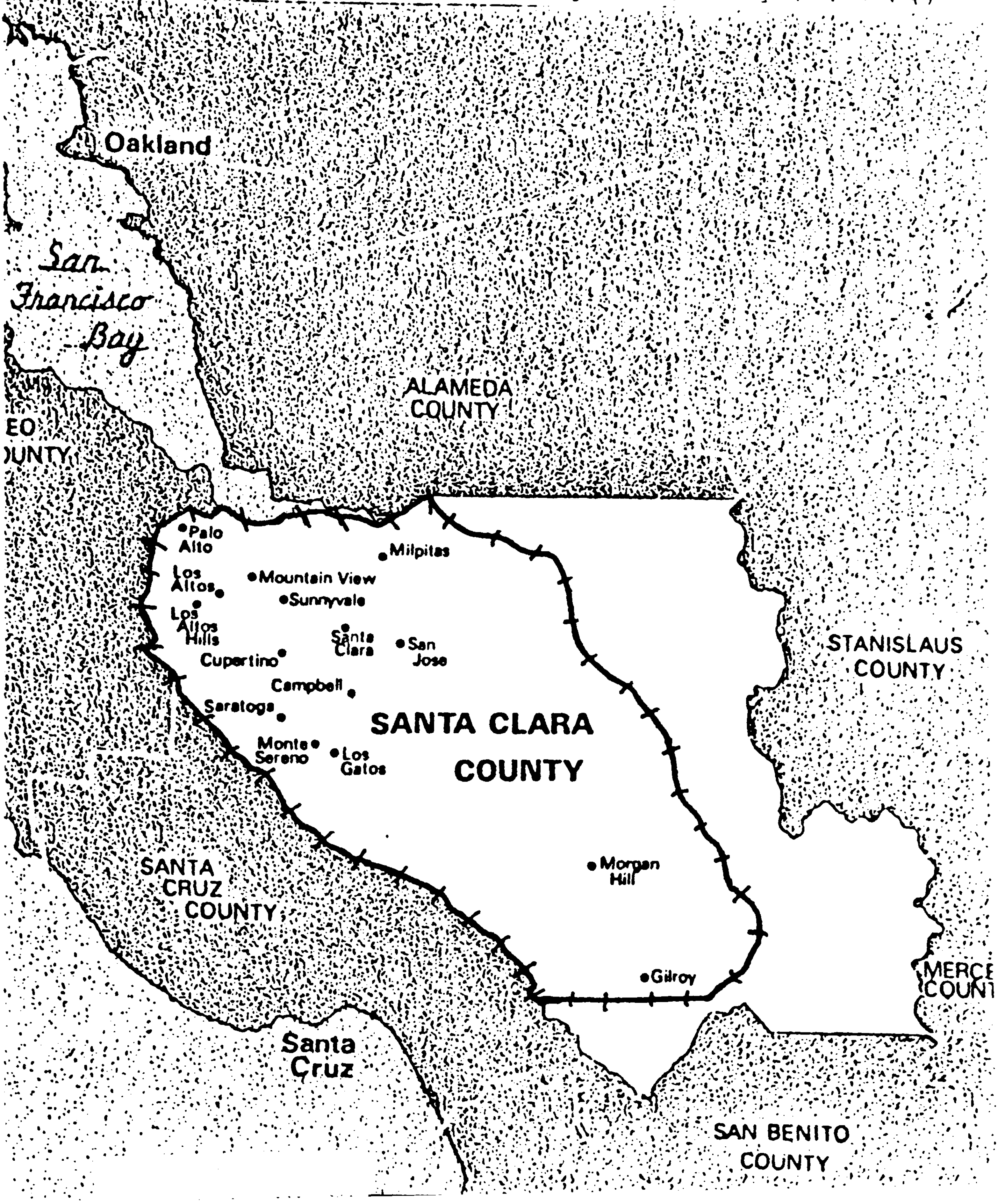
EPA chose to conduct an IEMP in the Santa Clara Valley in part because the industrial base and environmental concerns were substantially different from those of other areas under study. In the last three to four decades, the area's population has grown rapidly to its current level of about 1.4 million. In addition, the local economy has shifted increasingly from agriculture to industry. In the 1970's, the area experienced a rapid growth in electronics and other high-tech, computer-related industry, becoming a world leader in this field.

Currently, the northern Santa Clara Valley is well populated and has an industrial economic base. The southern part of the Valley, by contrast, remains more sparsely populated, with an economy based on agriculture. The southern Santa Clara Valley, however, is expected to experience significant population and industrial growth in the coming decades. The IEMP study area, which roughly corresponds to the Santa Clara Valley, is shown in Figure 1.

Some of the Santa Clara Valley's environmental concerns are at least partly a result of its unique industrial base. In recent years, the discovery of groundwater contamination caused by leaks and spills from underground tanks and other waste storage areas has generated widespread public concern; many of these leaks occurred on the grounds of electronics firms. Other sources of toxics in the local environment are common to most urban areas, and include automobiles, dry cleaners, sewered industrial liquid wastes, and disinfection of drinking water supplies. The southern Santa Clara Valley has high nitrate levels in its groundwater from past agricultural activity.

The decision to conduct an IEMP in the Santa Clara Valley followed extensive discussions by EPA with state and local officials, industry representatives, and public interest groups. EPA was especially impressed by the local response to groundwater problems associated with underground storage tanks. In 1982-83, a coalition of local elected and regulatory officials, industry representatives, and environmental leaders responded effectively to the discovery of groundwater contamination in the Santa Clara Valley. Working together, these local leaders drafted a new model Hazardous Materials Management Ordinance (HMMO) to regulate the storage and handling of industrial chemicals; most of the cities and the county then enacted these ordinances within their respective jurisdictions. The IEMP could thus build upon an unusually active coalition of local interests committed to effective management of environmental risks.

Figure 1 Santa Clara Valley IEMP Study Area (Shown by ┼┼┼┼┼)



Public Participation

In conducting the Santa Clara Valley IEMP, the EPA has put a great deal of emphasis on public participation and cooperation with other agencies. At the project's outset, EPA established two advisory committees: an Intergovernmental Coordinating Committee (ICC), consisting of local elected officials and board members of regulatory agencies; and a Public Advisory Committee (PAC), including staff of regulatory agencies, industry and public interest groups, and others.

The committees have provided a public forum in which to discuss complex environmental problems and sensitive issues of public health, and a process by which to build understanding and consensus within the community. In addition, the committees have provided a vehicle for fostering cooperation among the regulatory agencies and local leaders who need to work together to manage environmental risk effectively. Local participation through the advisory committees has substantially improved both the quality of the IEMP analysis and the opportunities for the project to make useful contributions.

METHODOLOGY

The IEMP applies the techniques of risk assessment and risk management to environmental problems. Risk assessment is a means of evaluating the potential health impact of exposure to chemicals in the environment. Risk assessment allows decision-makers to compare the potential effects of different pollutants (such as trichloroethane and benzene), exposure pathways (such as air and drinking water) and sources (such as underground tanks and automobiles), using a common denominator of human health risk. By providing estimates of the comparative impacts of different toxic chemicals and sources, risk assessement can be used to identify the most serious problems.

Risk management is the process of controlling the health risks identified through risk assessment. Risk management considers not only the level of risk posed by a particular pollutant or source but also the feasibility and cost of control, public preferences, and institutional capabilities. Setting priorities for research and risk reduction is a key aspect of risk management.

This report presents the results of the first phase of the IEMP, which emphasized risk assessment of a broad set of toxic pollutants and sources. The project's second stage, now beginning, will emphasize risk management of a selected set of priority problems.

Risk Assessment

This study uses risk assessment to evaluate and compare the potential health risks from toxic pollutants in the air, land and water. Several measures of risk are used in this report, including estimated risk to particular individuals and projected risk for an entire population.

Risk to an individual is defined as the increased probability that an individual exposed to one or more chemicals will experience a particular adverse health effect during the course of his or her lifetime. It is important to realize that the risk estimated for a particular type of exposure is the incremental risk beyond that which a person faces from exposure to other environmental or hereditary causes of disease, sometimes referred to as the background rate of disease. In this report, we present two types of estimated individual cancer risks: (1) average individual risk, for the typical individual, and (2) risk to the most-exposed individual (MEI), who may be particularly close to a source or is highly exposed for some other reason. As explained below, for non-cancer effects, this study estimates whether or not exposures appear to be high enough to place a person at increased risk of an adverse health effect.

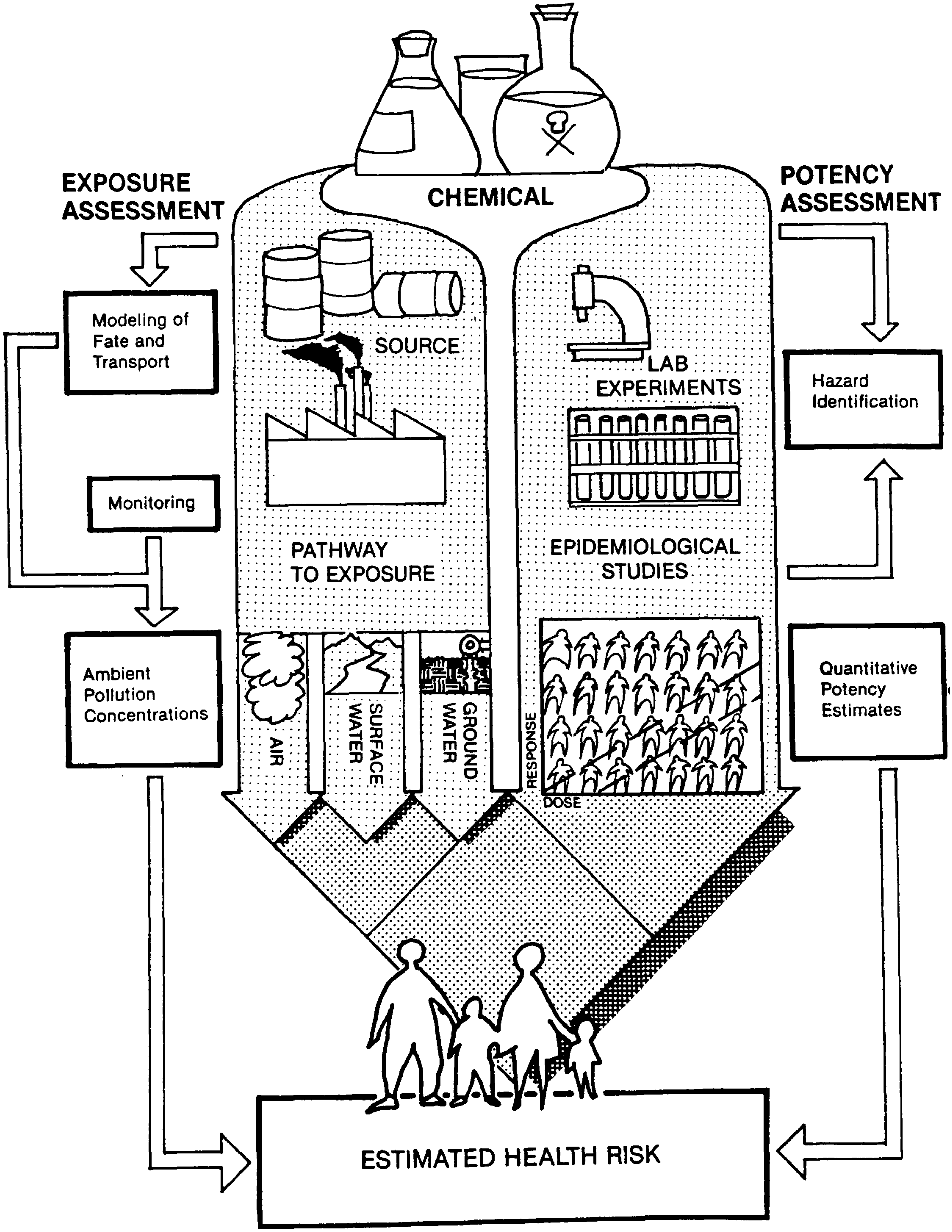
Risk to the population is the expected increased incidence (number of cases), above the background rate, of an adverse health effect in an exposed population. In this report, we present potential increased numbers of cases of cancer resulting from estimated exposure to particular chemicals and pollution sources. For health effects other than cancer, estimates of the number of people exposed at levels high enough to pose some increased risk are presented.

The two key elements in estimating risk are a chemical's estimated potency, or toxicity, and human exposure to that chemical. EPA estimates a chemical's toxicological potency on the basis of available scientific evidence. Scientific data typically consist of laboratory studies of animals exposed to a chemical under controlled conditions, or epidemiologic studies of human exposure to a chemical, usually in an occupational setting. Exposure to a chemical is estimated by measuring or estimating the concentration at which a chemical is present in the air or water, and then making assumptions about how much air a person breathes or water he or she drinks. Finally, potency and exposure estimates are combined to estimate individual and population risks. This methodology is illustrated in Figure 2.

This project examined cancer and a number of other toxic effects, such as birth defects, neurobehavioral effects, and effects of the immune system, blood, liver, and kidney, that might result from long-term exposure to environmental pollutants. Since methods of estimating cancer risks are fairly well developed and accepted, it was possible to develop estimates of the potential individual risks and aggregate incidence (number of cases) for exposure to carcinogens.

EPA's Carcinogen Assessment Group (CAG) has established a method for evaluating the potential cancer risk from a substance. First, CAG evaluates the weight of evidence that a substance poses a cancer risk to humans.

FIGURE 2 IEMP RISK ASSESSMENT METHODOLOGY



For those substances that may pose some risk, CAG provides a quantitative estimate of their potency, or toxicity. The IEMP used the CAG evaluations and, in a few cases, developed additional evaluations for substances not yet studied by CAG.

No equivalent and accepted techniques exist for estimating the probability or incidence of non-cancer effects (an experimental technique for making such estimates is now being evaluated by scientists within and outside EPA). Therefore, in evaluating the potential health risks for effects other than cancer, this study relied on "no-effect" thresholds, also referred to as EPA Reference Doses (RfDs) or Acceptable Daily Intake levels (ADIs). Thresholds, or RfDs, represent an estimated dose below which adverse health effects are assumed not to occur in most people. In evaluating non-cancer effects, the IEMP estimated the number of people who might be exposed at levels above an estimated no-effect threshold, and therefore might be at risk of a toxic effect. However, the IEMP could not estimate the possible number of cases that might occur as a result of such exposures.

The IEMP performed an initial screening exercise to identify, from a master list of about 1800 pollutants, those chemicals most likely to pose an environmental health risk in the Santa Clara Valley. Using a combination of exposure and toxicity criteria, the project initially identified about 50 chemicals that might pose such risks. For this report, exposure and health risks were estimated for 41 pollutants - all those for which sufficient exposure evidence and toxicological data could be found. These chemicals, an indication of their suspected toxic effects, and their likely routes of exposure are shown in Table One.

In estimating the possible toxic health effects of such a diverse set of pollutants, sources and exposure routes, the IEMP encountered a number of very significant uncertainties and data gaps. In general, the IEMP approach to this problem was to use conservative, or pessimistic, assumptions likely to overstate possible health impacts. In addition, the study made extensive use of sensitivity analysis of key issues, in which health risks are estimated under several different assumptions. Sensitivity analysis is useful in showing whether important results are "robust," i.e., whether they hold up under a variety of different assumptions. In pinpointing the importance of alternative assumptions in affecting estimates of health risk, such analysis also can help to identify those areas where research to provide better information is most important.

It is important to remember that the estimates of individual health risk and aggregate incidence from exposure to toxics presented in this report should not be interpreted as precise or absolute estimates of future health effects. The simplifying assumptions and uncertainties in both the toxicology and the exposure components of this study are simply too great to justify a high level of confidence in the predictive value of the results. (The important limitations and uncertainties are summarized below.) The value of these estimates lies in their usefulness for comparing problems to one another, developing a rough notion of the magnitude of possible effects, and setting priorities for risk management.

TABLE ONE

TOXICS IN SANTA CLARA VALLEY
SUMMARY OF HEALTH EFFECT AND EXPOSURE DATA

TOXIC SUBSTANCE	POTENTIAL ADVERSE HEALTH EFFECTS Type of Effect Considered in IEMP [2]		EXPOSURE PATHWAYS [1] Sources of Information on Presence of Toxics in Santa Clara Valley [3]	
METALS AND MINERALS	CANCER	NON-CANCER	OUTDOOR AIR	DRINKING WATER
ARSENIC	X [4]	X	MONITORED	MONITORED
BARIUM		X	MONITORED	MONITORED
BERYLLIUM	X	X	MONITORED	-
CADMIUM	X [5]	X	MONITORED	MONITORED
CHROMIUM	X [5]	X	MONITORED	MONITORED
FLUORIDE		X	-	MONITORED
LEAD			MONITORED	MONITORED
MERCURY		X	-	MONITORED
NICKEL	X	X	MONITORED	-
NITRATES		X	-	MONITORED
SELENIUM		X	-	MONITORED
SILVER		X	-	MONITORED
ZINC		X	MONITORED	MONITORED
ORGANIC CHEMICALS				
BENZO(A)PYRENE (BAP)	X	X	ESTIMATED	-
BENZENE	X	X	MODELED	MODELED
BROMOFORM	X	X	-	MONITORED
CARBON TETRACHLORIDE	X	X	SHORT-TERM MONITORING	MONITORED
CHLOROFLUOROCARBON (CFC-113)		X	MODELED [6]	MONITORED
CHLOROFORM	X	X	MODELED	MONITORED/ MODELED [7]
CHLORODIBROMOMETHANE	X	X	-	MONITORED
CHLORAMINES		X	-	MONITORED

TABLE ONE (cont.)

TOXICS IN SANTA CLARA VALLEY
SUMMARY OF HEALTH RISK AND EXPOSURE DATA

TOXIC SUBSTANCE	POTENTIAL ADVERSE HEALTH EFFECTS Type of Effect Considered in IEMP [2]		EXPOSURE PATHWAYS [1] Sources of Information on Presence of Toxics in Santa Clara Valley [3]	
	CANCER	NON-CANCER	OUTDOOR AIR	DRINKING WATER
DICHLOROBENZENE		X	MODELED [6]	-
DICHLOROBROMO-METHANE	X	X	-	MONITORED
1,2 DICHLOROETHANE	X	X	MODELED [6]	-
1,1 DICHLORO-ETHYLENE (DCE)	X	X	MODELED [6]	MONITORED/ MODELED [7]
1,2 DCE			-	MONITORED
DBCFCP			-	MONITORED
ETHYLENE DIBROMIDE	X	X	ESTIMATED	MODELED
ETHYLENE OXIDE	X	X	MODELED	-
GASOLINE VAPORS	X		MODELED	-
GLYCOL ETHERS		X	MODELED [6]	-
ISOPROPYL ALCOHOL			MODELED [6]	-
METHYLENE CHLORIDE	X	X	MODELED	MODELED
METHYL ETHYL KETONE (MEK)		X	-	MODELED
PERCHLOROETHYLENE (PCE)	X	X	MODELED	MONITORED/ MODELED [7]
PESTICIDES*	X	X	-	MONITORED*
PHENOL		X	MODELED [6]	-
TOLUENE		X	MODELED	MODELED
1,1,1-TRICHLORO-ETHANE (TCA)	(8)	X	MODELED	MONITORED/ MODELED [7]
TRICHLOROETHYLENE	X	X	MODELED	MODELED
VINYL CHLORIDE	X	X	-	MODELED
XYLENE		X	MODELED	MODELED

FOOTNOTES TO TABLE ONE:

1 The IEMP also performed limited analysis of the possible risks to a hypothetical individual regularly consuming contaminated fish caught from the South Bay; see text and Table Six. The South Bay was not thought to be an exposure pathway by which toxics affected many people, and thus is not included on this table.

2 "X" indicates evidence of adverse, chronic health effect in animals or humans. This table summarizes the type of potential adverse health effect (cancer or non-cancer) considered for purposes of the IEMP report. For a more complete discussion on pollutant selection and toxicological evaluation of adverse health effects from pollutants see chapter 2 - General Methodology.

3 The IEMP used different types of information to estimate the potential exposure of Santa Clara Valley residents to some level of a toxic substance. Monitored data are obtained by collecting and analyzing samples from the air or water in Santa Clara Valley. Modeling is a way of estimating the ambient environmental concentration of a pollutant by calculating the estimated dispersion pattern from sources known to emit the substance. Estimated exposure is done in different ways depending on available data as described more completely in the full report.

4 There is some dispute as to the carcinogenicity of low levels of arsenic in drinking water. See text.

5 Cadmium and (hexavalent) chromium are assumed to be carcinogenic through inhalation only, not ingestion.

6 These pollutants were modeled only to estimate exposures to most-exposed individuals (MEIs) near certain sources.

7 Current exposure to this chemical was derived from monitoring data. Possible future exposure was modeled.

8 In accordance with current EPA policy, the IEMP does not consider TCA to be a carcinogen in its base case. For sensitivity analyses, however, the IEMP does examine the impact of TCA as if it were a carcinogen.

* Drinking water sources have been monitored for a number of pesticides. However, little evidence of pesticide contamination was found. See chapter 4.

AIR ANALYSIS

In California, the regulation of sources of air pollution is the responsibility of the state Air Resources Board (ARB) and local Air Quality Management Districts. The ARB establishes emissions requirements for motor vehicles and has oversite responsibilities for control of other sources of air pollution in the state. The local Bay Area Air Quality Management District is directly responsible for regulating non-vehicular sources of air pollution in the Santa Clara Valley.

While the historical emphasis of air pollution control efforts has been on criteria pollutants, such as those causing smog, this study examines toxic pollutants, which may pose health risks at comparatively low environmental levels. The IEMP Stage I analysis of risk from exposure to toxics present in outdoor air involved the study of three classes of toxic air contaminants: organic gases, heavy metals, and organic particulates.

Organic gases. The IEMP analysis of exposure to organic gases focused on eleven specific organic compounds plus gasoline vapors, a mixture of compounds. This broad class of chemicals comes from many sources. Some gases, such as benzene and ethylene dibromide, are emitted to the atmosphere from fuel combustion or evaporation. Motor vehicles are a major source. Emissions of other organic gases, such as 1,1,1-trichloroethane and methylene chloride, result (generally through evaporation) from the use of solvents by electronics firms, other industrial and commercial establishments, and households.

To analyze exposure to and risk from organic gases in outdoor air, the IEMP and the Bay Area Air Quality Management District (AQMD) developed estimates of toxic gas emissions from various sources, and then modeled pollutant dispersion to arrive at estimated pollutant concentrations in the ambient air. The analysis examined 25 major point sources, such as semiconductor facilities and other industrial plants; and a variety of small, dispersed area sources, including motor vehicles, industrial solvent applications, fuel combustion for home heating and dry cleaners. The organic gases emissions inventory and the dispersion model were used to estimate human exposure and risk from different sources and pollutants.

The IEMP also estimated toxic organic releases and risks from three sources not included in the AQMD inventories: sewage treatment plants, municipal landfills, and groundwater aeration facilities.

Metals. Analysis included eight toxic metals, such as arsenic, chromium and cadmium. These metals are released to the air primarily as a result of various forms of combustion (metals are present in trace quantities in most fuels). Airborne metals may also be present as a result of windblown dust, which may contain the settled particles from past emissions.

EPA relied on long-term monitoring data from downtown San Jose to estimate the concentrations of metals throughout the Valley and to project risks from exposures to toxic metals. No emissions inventory for metals has yet been developed. While the monitoring data are fairly reliable, countywide projection of these concentrations is problematic. Since it is likely that most metals sources are dispersed area sources (likely to result in a more even distribution pattern than pollution dominated by point sources), and that downtown San Jose metals concentrations are probably somewhat higher than average for the Valley (as is the pattern with most other pollutants), EPA judged that an appropriately conservative assumption for this screening analysis was to estimate risks as if the single site's monitoring data were representative of the Valley.

Organic particulates. Organic particulates, such as benzo(a)pyrene, are toxic organic chemicals present in the air primarily in particulate, rather than gaseous, form. Sometimes called products of incomplete combustion (PICs), they are the result of fuel combustion from motor vehicles, home heating sources (such as fireplaces and wood stoves) and other sources.

No local monitoring or emissions data exist for organic particulates. EPA made rough estimates of local levels of these chemicals by scaling national and other data to local levels based on known sources of organic particulates (such as residential heating and gasoline combustion) and on local monitoring data for total suspended particulates, the best available proxy for organic particulates. These estimates are adequate for identifying the general magnitude of the problem, but better local data would be needed to support regulatory actions.

DRINKING WATER ANALYSIS

Drinking water in the Santa Clara Valley comes from three sources: local groundwater, surface water imported through the South Bay and Hetch Hetchy Aqueducts, and local surface water. About half the drinking water in the Valley is groundwater, and about half is surface water. Large volumes of imported and local surface water are used to recharge the groundwater basin artificially, both to prevent the depletion of the aquifer and to store water supplies at relatively low cost.

Nineteen water retailers - some municipal and some private - deliver water to the Valley's consumers, under regulation by the California Department of Health Services. The Santa Clara Valley Water District (SCVWD) imports and treats surface water (some imported water is purchased directly from the City of San Francisco via the Hetch Hetchy Aqueduct) and is responsible for overall management of the Valley's groundwater resources. The San Francisco Bay Regional Water Quality Control Board (RWQCB) has primary responsibility for protecting groundwater quality (although the SCVWD and municipal authorities are also involved in protecting groundwater quality). The state Department of Health Services (DOHS) has primary responsibility for ensuring the quality of drinking water delivered by major public systems.

Toxic contamination problems, as well as available data, differ for surface water and groundwater. The issues studied in the Stage 1 analysis include:

- By-products of water treatment (disinfection). Disinfection of water by chlorination and related processes results in the creation of chloroform and other "trihalomethanes." Disinfection of drinking water is necessary to protect people from diseases that might otherwise result from microbial contamination. Since most groundwater is not disinfected (microbial contamination is not usually a problem with groundwater in the Santa Clara Valley), this is primarily a concern with surface water.

- Metals and minerals. A number of inorganic substances, including metals that may cause toxic effects, are found in drinking water in the Santa Clara Valley. Most of these substances are probably from natural background sources (e.g., substances naturally present in the soil), although some may be from past or present man-made contamination. Metals and minerals are present in both imported surface water and in groundwater.

- Pesticides. Runoff from agricultural areas through which imported surface water travels may contaminate the water with pesticides. Groundwater may be contaminated through local pesticide use.

- Industrial chemicals from tanks, pipes and spills. The contamination of local groundwater through leaks of underground storage tanks, piping or simply through sloppy handling has become a significant local concern since the discovery of a leak at Fairchild Camera & Instrument in 1981. About 100 sites involving industrial contamination of soil or groundwater have since been discovered in the Valley; EPA has added six of these sites to its Superfund National Priority List, and has proposed adding an additional twelve. Many sites involve contamination by industrial solvents, such as trichloroethylene and perchloroethylene.

- Fuels from tanks, pipes and spills. Santa Clara Valley has about ten times as many fuel storage tanks as industrial chemical storage tanks. The San Francisco Bay Regional Water Quality Control Board has documented over 400 leaks and spills from fuel tanks. Toxic contaminants in fuels include ethylene dibromide and benzene.

- Organic chemicals from other sources. Organic chemicals may contaminate groundwater by leaking from sewer lines that contain industrial wastewater. While toxic wastes are formally barred from Class III sanitary landfills (the only landfills sited in Santa Clara Valley), such wastes may be present in household and commercial waste. According to the RWQCB, there is evidence of historical disposal of organic chemicals in municipal landfills.

Other potential sources of organic chemical contamination of groundwater include above-ground chemical tanks and storage areas; residential use of chemicals such as pesticides and cleaning agents; leakage from septic tanks; illegal dumping; and dry wells.

- Nitrates. Nitrates, which can cause methemoglobinemia, or "blue baby syndrome," may be present in groundwater as a result of fertilizer use, animal waste, and leakage from septic tanks and sewered wastes. Parts of southern Santa Clara Valley have high nitrate levels, and the City of Morgan Hill is under order from the state Department of Health Services to come into compliance with state and federal standards for nitrates in drinking water by 1988.

Different methods were used to assess exposure and risks from these different sources and pollutants. Historical monitoring data were used to estimate exposure to metals and minerals. To estimate exposure to trihalomethanes, the IEMP obtained monitoring data that reflect recent changes in treatment practices and water quality. Direct monitoring was also used to assess exposure to pesticides, but these data are less complete. Risks from nitrates in the groundwater of the south County were estimated by calculating the number of infants who might be exposed to nitrate levels high enough to be of concern, based on monitoring data. Current risks from contamination of drinking water by industrial chemicals were estimated based on recently collected monitoring data for public systems. (No comparable data were available for private wells used as sources of drinking water.)

Estimating the extent of possible future exposure to groundwater contamination from leaking fuel and industrial tanks and other sources was the most complex part of the drinking water analysis. Current groundwater contamination, as well as future leaks and spills, may affect drinking water wells that are currently unaffected, or worsen contamination at already affected wells. At the same time, recently instituted programs to improve tank construction, monitor groundwater near potential sources, clean up contamination sites and monitor drinking water wells will significantly reduce risks from what they might have been in an unregulated world. To estimate possible risks over time, the IEMP modeled possible future contaminant releases, movement and impact on drinking water wells. This effort took into account variations in hydrogeology; voluntary replacement of old tanks; and regulatory programs to prevent and clean up contamination, and to monitor drinking water wells.

In general, the drinking water analysis based on monitoring data is more reliable than that based on modeling. The analysis of future risks from groundwater contains the greatest uncertainties. Because of this, the modeling effort was consistently conservative, so as not to underestimate potential risks. In addition, extensive sensitivity analysis was performed to examine alternative assumptions for key factors such as the size of tank leaks and the effectiveness of regulatory actions.

SOUTH SAN FRANCISCO BAY SURFACE WATERS

Surface water contamination in the South San Francisco Bay and its tributary streams occurs as a result of "non-point source" runoff from both urban and rural areas, and through releases from identifiable "point" sources, including sewage treatment plants and industrial facilities. Fairly high levels of metals exist in the water and in the sediment of the Bay, and both metals and organic chemicals (mostly pesticides) have been found in fish and shellfish tissue.

While toxic (and conventional) pollutants are of concern because of their potential impact on the health of the aquatic ecosystem, their likely impact on human health appears to be small by comparison to the other exposure routes examined. The IEMP was unable to estimate the number of people exposed to toxics through South Bay surface waters, but it seems unlikely that such exposure is widespread. South Bay water is not a drinking water source. In addition, relatively little swimming occurs, because of limited access. The main exposure route of concern appears to be possible consumption of contaminated fish or shellfish. Since it is possible that some persons consume such fish regularly, the IEMP calculated possible individual risks for a hypothetical individual consuming significant quantities of contaminated local fish.

LIMITATIONS AND UNCERTAINTIES

An understanding of the uncertainties and limitations that underlie the IEMP analysis is critical to a proper interpretation of its results. Limitations in the scope of what was studied, and uncertainties in both the exposure and toxicological data, argue against taking the estimates too literally. Nevertheless, decision-makers must often act now to protect against health threats from toxic chemicals and cannot afford to wait for scientific certainty. The IEMP analysis uses the best information available today to estimate health risks from toxics so that decisions that cannot wait will be as informed as possible.

Limitations in Scope

The reader should recall that this analysis does not directly examine disease incidence in the local population and attempt to link it with environmental exposure. Because the analysis is not an epidemiologic study, it is not intended to and does not answer questions such as what may have caused a statistically higher rate of birth defects in the Los Paseos area. Instead, the IEMP attempts to evaluate what health effects might result from current and future environmental exposures.

This analysis does not attempt to estimate the health risks from all chemicals that individuals may be exposed to in their daily lives. The IEMP did not estimate risks from indoor air contaminants, nor those from occupational exposures. (The IEMP has commissioned a scoping study on occupational exposures, which is now in progress.) Similarly, risks from contaminants in food are not estimated. Omitting analysis of these routes of exposure does not imply that they are unimportant; indeed, it is quite possible that risks from any of these exposure pathways could exceed risks from the exposures that we did examine. The IEMP decided not to assess these exposure routes because of resource limitations and because they are outside EPA's traditional purview and area of expertise.

The IEMP chose not to analyze exposure to and risks from conventional pollutants in air and water (such as ozone and oxides of nitrogen and sulfur in air, and oxygen-depleting substances and oil and grease in water) because EPA believed it could make a more significant contribution by concentrating on less well understood and less regulated toxic chemicals (largely organic chemicals and heavy metals thought to be potentially hazardous at low levels).

Finally, the IEMP did not estimate risks from possible infrequent, accidental releases of toxic chemicals, such as a major release of a toxic gas. (The study did estimate risks from more frequent and predictable accidental releases, such as tank leaks and chemical spills.) The probability and magnitude of such an accident is very difficult to estimate, and the likely risk from such an event is therefore difficult to quantify. The omission of such events from this analysis does not imply that possible accidents are not an important environmental and public health concern.

In sum, it should be clearly understood that this report is not an analysis of health risks from all possible exposures to potentially dangerous chemicals in the Santa Clara Valley.

Limitations in Exposure Data

Beyond these intentional limitations in scope, the study's exposure and toxicological estimates are uncertain in a number of potentially important ways. On the exposure assessment side, one limitation of the analysis is that it did not exhaustively examine all sources and pollutants. While the IEMP has tried to identify and assess risks from the most significant sources and pollutants, it was unable to estimate exposure to some chemicals, such as arsine and phosphine, because of a lack of data. In reality, of course, chemicals not included in the study may also pose some health risk.

Even where exposure data were available, those data varied significantly in their quality. Thus, the resulting exposure estimates vary in their reliability. Those based on extensive monitoring, such as for trihalomethanes and inorganic substances in water, are probably fairly good. Those based on less extensive monitoring, such as for metals in air (based on a single long-term monitoring station) are somewhat less reliable.

Exposure estimates derived from modeling also vary in their reliability. Estimates of exposure to toxic organic chemicals in air, calculated using a dispersion model, are dependent primarily on the quality of the emissions estimates and other factors such as meteorological data. The range of possible error for most pollutants is probably well under an order of magnitude. The analysis of the future risks from groundwater contamination, which relies heavily on engineering assumptions and modeling of future events, is more uncertain. Where there are significant uncertainties, such as in the groundwater exposure analysis, we have attempted to make assumptions that are likely to err on the side of overestimating possible health impacts. In addition, we have performed sensitivity analysis of particularly important variables, such as possible chemical reactions and the effectiveness of regulatory actions.

Limitations in Toxicological Data

Estimates of the potential health effects of particular chemicals are designed to be conservative (i.e., more likely to overestimate toxic health effects than to underestimate them) in several ways. Health effects observed in laboratory animals are assumed to be a reasonable indicator of potential effects in humans. In converting the animal data to predicted human responses, and in extrapolating from high doses to low doses, EPA uses models that yield a plausible upper-bound estimate of potency rather than a "best guess" estimate.

On the other hand, many substances of potential concern have never been evaluated scientifically, or have not been evaluated in sufficient detail to allow estimation of effects on humans. For example, lead (present in air, water, and dust) is thought to pose a health risk to children at ambient levels; currently, however, EPA has no established way of estimating individual risks or numbers of possible cases. EPA is likely to be aware of the dangers from many of the most potent chemicals, since the evidence for their toxicity will typically be the most obvious; however, it is possible that some chemicals about which we currently know little may someday be demonstrated to be toxic.

Because of the many uncertainties and potential omissions, it is impossible to say whether the total risk estimates presented here are over- or underestimates of total toxic health risks from pollutants in air and drinking water. For those chemicals for which the IEMP was able to make quantitative estimates of exposures and risks, it is more likely that risks are overestimated than underestimated. To the extent that toxic chemicals about which we currently know little have been left out, risks may be underestimated. The value of the IEMP methodology is that it allows an evaluation and comparison of the health risk from chemicals and pollution sources about which we know something. Management of these risks, based on the best current information, can proceed, while research continues on the effects of chemicals about which little is currently known.

RESULTS OF STAGE I RISK ASSESSMENT

A brief summary of estimated environmental exposures is presented below, followed by a presentation of estimated health risks from environmental toxics.

Exposure

Detailed estimates of exposure to toxic chemicals are too lengthy to present in this summary; the interested reader is referred to the full report. In air, dispersion modeling of toxic organic substances indicates that pollutant concentrations are generally highest in the northern part of the study area, which is more industrialized and more heavily populated. Monitoring data for toxic metals indicates that they are present in the Santa Clara Valley's outdoor air at low levels - in some cases, the lower end of the range of concentrations is below the detection limit for the analytic equipment used.

Overall, concentrations of air toxics modeled or monitored in the Santa Clara Valley appear to be similar to or lower than pollutant concentrations typical of urban areas. Estimated average concentration levels for most chemicals examined were below 5 micrograms per cubic meter (ug/m^3).

Estimated exposures to most-exposed individuals (MEIs) near sources of air toxics (such as semiconductor facilities, dry cleaners and traffic intersections) were typically five to one hundred times higher than the average concentration levels. The difference between average and MEI exposures was greater for chemicals such as ethylene oxide and chloroform whose emissions were dominated by a few point sources, and less for chemicals such as xylene and toluene, which are emitted by many dispersed sources.

About half the population in the Santa Clara Valley is exposed to trihalomethanes in treated drinking water, at levels that are fairly typical for disinfected water (about 20-80 micrograms per liter (ug/l)). Highly exposed individuals are estimated to be exposed to THM levels at the high end of this range but below the 100 ug/l standard.

Thirty-six public wells and about 56 known private wells have been affected by industrial chemicals. In the majority of cases where a source has been identified, the pollution has resulted from leaking underground tanks or associated chemical spills. Some operating public wells are serving water containing 1,1,1-trichloroethane, perchloroethylene, 1,1,2-trichloro-1,2,2-trifluoroethane, carbon tetrachloride, and a few other chemicals in the low parts per billion, well below current state drinking water standards. (The highest concentration level recorded at an operating public well is seven parts per billion, or ug/l). About 129,000 people are currently drinking water from public wells with low levels of contamination.

Recent testing by the County Health Department of 171 private wells found that about 8% of the wells were affected by detectable contamination by synthetic organic chemicals, and that almost 40% were affected by bacteriological contamination (i.e., they were unsanitary). Wells were not selected by random sampling, so these figures are not necessarily representative of other private wells in the Valley.

Modeling of possible future drinking water contamination under conservative (pessimistic) assumptions yielded estimated exposures significantly higher than current levels, and included some pollutants (such as gasoline constituents) not yet seen in drinking water wells. Concentration levels were estimated to be significantly higher at private wells than at public wells, because public wells benefit from greater regulatory and natural hydrogeologic protection. The IEMP estimated that future exposure to contaminated groundwater sources of drinking water could affect 10% of the population, in addition to those already affected.

In the southern part of the county, several public wells and an unknown number of private wells contain levels of nitrates that are above state and federal standards. Large systems exceeding standards are under order to comply by 1988. Little evidence was found of pesticide contamination of drinking water, either in local groundwater or in imported surface water.

Health Risks

1. Overall Cancer Risk: EPA's findings suggest that the estimated cancer risks from the toxic chemicals and sources studied are apparently a small proportion (well below one percent) of total cancer cases in the Valley. Since any level of exposure to a carcinogen is assumed to pose some risk, all 1.4 million residents of the Santa Clara Valley are projected to face some level of increased cancer risk as a result of environmental exposure. EPA estimated that exposure to the pollutants and sources examined may be responsible for about four cases of cancer per year; an estimated 3,600 cases of cancer occur annually in Santa Clara County.[1] This finding, although tentative, provides an important perspective on health risks from toxic chemicals in the outdoor air and drinking water in the Santa Clara Valley as compared to other possible means of exposure to toxic substances, such as smoking, diet, occupation, and indoor air. However, it is important to keep in mind that this study examined a relatively small number of known toxic chemicals; exposure to many thousands of chemicals in the air and drinking water about which we know little may also be a source of significant, although currently unknown, health risk.

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1 Ratio of estimated cancer cases to estimated cancer deaths, from 1983 national data from the American Cancer Society: 1.93. Cancer deaths in Santa Clara County, 1984: 1,879. 1,879 cancer deaths X 1.93 cases/death = 3,626 estimated cancer cases in Santa Clara County.

Average individual cancer risk estimates for typical individuals exposed to toxics in both air and drinking water indicate a potential increase in cancer probability of about 200 in a million over a lifetime. This estimate of increased risk is the projected cumulative risk for exposure to all sources and pollutants examined. Projected individual cancer risk is a small proportion of the total lifetime cancer risk for an average person of about one in four (250,000 in a million). Of course, individuals who are particularly highly exposed to chemicals, by virtue of their proximity to a source or for some other reason, may face significantly higher-than-average cancer risk. (Risks to such highly-exposed individuals are discussed below.)

2. Non-cancer Risks: EPA estimated that about 10% of the population in the Santa Clara Valley may be exposed to chemicals at levels high enough to pose a risk of effects other than cancer. Populations estimated to be at risk of non-cancer health effects due to exposures above no-effect thresholds are shown in Table Two.[1]

The IEMP estimated that exposure to benzene in the air could pose an increased risk of lowered blood cell counts to about 100,000 people in the Santa Clara Valley. This exposure is the most widespread exposure, at a level above an estimated no-effect threshold, of any chemical examined. Benzene is released primarily by vehicles.

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[1] TCA has not demonstrated any teratogenic potential in published studies conducted using rodent species. Therefore, the IEMP base-case analysis assumes that exposure to TCA poses no risk of fetal effects. An unpublished study, which has not undergone scientific peer review, reports fetotoxic effects (cardiac malformations) in rat pups exposed in utero to TCA (Dapson et al., 1984). In order to assess the importance to Santa Clara Valley residents of further research on this issue, the IEMP uses the Dapson study to examine the possible impact of TCA under the alternative assumption that exposures above an estimated threshold based on that study's results could pose the risk of fetal effects. THE SENSITIVITY RESULTS SHOULD NOT BE INTERPRETED AS INDICATING WHETHER OR NOT A RISK IN FACT EXISTS; EPA RECOMMENDS AGAINST USING THIS INFORMATION FOR RISK MANAGEMENT DECISION-MAKING OR REGULATORY ACTION. Under this alternative assumption, the IEMP projects that about 3,000 people, mostly those using private wells, could be exposed to levels of TCA in their drinking water that exceed the estimated threshold. In addition, most-exposed individuals downwind of an industrial facility are projected to be exposed at levels above the estimated threshold in the air. These findings suggest that more research is appropriate, both on actual levels of exposure and on TCA's potential adverse effects. The National Toxicology Program has commissioned a project to repeat the limited Dapson study; results are expected in Fall of 1986.

TABLE TWO

POPULATIONS ESTIMATED TO BE AT RISK OF NON-CANCER HEALTH EFFECTS IN SANTA CLARA VALLEY, BY POLLUTANT

POLLUTANT	EXPOSURE PATHWAY	POTENTIAL HEALTH EFFECTS [1]	POPULATION EXPOSED ABOVE NO-EFFECT THRESHOLD	PRIMARY SOURCE(S)
VOLATILE ORGANIC CHEMICALS				
Benzene	Air	Blood	100,000	Motor Vehicles
1,1 Dichloro-ethylene	Water	Liver, kidney	20 - 340	Underground Tanks
Methylene Chloride	Water	Liver, fetal	0 - 50	Underground Tanks
1,1,1 Trichloro-ethane [2]	Water	Liver, neuro-behavioral	10 - 100	Underground Tanks
Trichloro-ethylene	Water	Liver, neuro-behavioral	0 - 10	Underground Tanks
Vinyl Chloride	Water	Liver, kidney, cardiovascular	0 - 10	Underground Tanks
METALS AND INORGANIC SUBSTANCES				
Nitrates	Water	Blue baby syndrome	50 - 100	Fertilizer, Septic Tanks

NOTE: BECAUSE OF SIGNIFICANT UNCERTAINTIES IN THE UNDERLYING DATA AND ASSUMPTIONS, THESE ESTIMATES OF THE POPULATIONS POTENTIALLY AT RISK OF DISEASE ARE ONLY ROUGH APPROXIMATIONS. THEY ARE BASED ON CONSERVATIVE ESTIMATES OF EXPOSURE AND CHEMICAL TOXICITY. See Text. UNLIKE CANCER RISK ESTIMATES IN THIS REPORT, THESE ARE ESTIMATES OF POPULATIONS EXPOSED AT LEVELS THAT MAY POSE HEALTH RISK; THEY ARE NOT ESTIMATES OF POSSIBLE NUMBERS OF CASES OR PROBABILITY OF DISEASE.

1 In many cases, risks for most-exposed individuals (MEIs) were estimated without estimating populations involved. Such risk estimates are presented in table six.

2 The IEMP conducted sensitivity analysis on TCA for possible fetal effects. See footnote to text.

In the southern part of the Santa Clara Valley, nitrate contamination of groundwater supplies of drinking water is above threshold levels estimated to pose an increased risk to infants of methemoglobinemia, or blue baby syndrome. The IEMP estimates that up to 50 or 100 babies may, at any one time, be exposed to nitrate levels high enough to pose risk.

In addition, under some assumptions about the way groundwater contamination may affect drinking water supplies, the IEMP projects that several hundred people who drink from private wells could be at increased risk of a variety of effects - including birth defects and neurobehavioral, cardiovascular, liver, blood and kidney effects - from industrial contaminants from tank leaks and spills. Concentration levels in public well water are projected to remain below no-effect thresholds, even under conservative assumptions.

Substantial evidence exists that lead may cause toxic effects, including blood effects and decreased IQ, particularly in children, who are most sensitive to it. Lead is present in air, dust and water, as a result of combustion of leaded gasoline, use of lead solder in pipes, and other sources. The IEMP was unable to calculate risks from lead exposure in this analysis because of a lack of an accepted EPA method for doing so. The IEMP hopes to estimate health risks from lead in the Santa Clara Valley as a part of follow-on work in Stage II.

It is important to note that exposure to toxic chemicals in the air or drinking water may pose some health risk at levels below estimated thresholds if exposures from other sources - such as diet or occupation - are significant. Even in this instance, comparisons with estimated thresholds provide a useful indication of the significance of the portion of exposure due to outdoor air or drinking water. Environmental exposures at or near estimated thresholds are likely to pose a more significant added risk than exposures well below a threshold.

3. <u>Risks by Exposure Route: outdoor air and imported surface supplies of drinking water appear to be the major exposure routes by which toxic contaminants in the ambient environment are likely to affect most people.</u> The estimated breakdown of cancer risk by exposure route is shown in Table Three.

Estimated toxic health risk through different exposure routes (e.g., air or drinking water) generally reflects the extent of exposure to toxic chemicals through those routes. Exposure to air toxics is the most widespread; everyone breathes the air and all 1.4 million Santa Clara Valley residents are estimated to be at some increased health risk from toxic air pollutants. Not surprisingly, toxic chemicals in the air are estimated to pose the most significant health risks among the exposure routes studied, over two estimated additional cancer cases per year.

TABLE THREE

ESTIMATED INCREASE IN CANCER INCIDENCE
IN SANTA CLARA VALLEY, BY EXPOSURE PATHWAY

EXPOSURE PATHWAY	POINT ESTIMATE OF ANNUAL INCREASE IN CANCER INCIDENCE (Range)	WEIGHT OF EVIDENCE FOR CARCINOGENICITY [1]
Air	2.2 (0.8 - 7.8)	A-B2
Drinking Water		
Surface Water	1.3 (1.3 - 8.3)	A-B2
Groundwater	0.06 (0.04 - 0.3)	A-C
TOTAL	3.6 (2.1 - 16.4)	A-C

NOTE: BECAUSE OF SIGNIFICANT UNCERTAINTIES IN THE UNDERLYING DATA AND ASSUMPTIONS, THESE ESTIMATES OF DISEASE INCIDENCE ARE ONLY ROUGH APPROXIMATIONS OF ACTUAL RISK. THEY ARE BASED ON CONSERVATIVE ESTIMATES OF EXPOSURE AND POTENCY, AND ARE THEREFORE MORE LIKELY TO OVERESTIMATE RISKS THAN UNDERESTIMATE THEM. See text.

1. The weight of evidence of carcinogenicity for the compounds included in the analysis varies greatly, from very limited to very substantial. According to EPA's categorization of levels of evidence of carcinogenicity, A = proven human carcinogen; B1 = probable human carcinogen (limited human evidence); B2 = probable human carcinogen (insufficient human evidence but sufficient animal evidence); C = possible human carcinogen D = not classifiable; E= no evidence.

Cancer risks from imported drinking water supplies are estimated to be somewhat lower than those from air sources - slightly over one additional case per year. This estimated risk results primarily from exposure to disinfection by-products, to which half the Valley's population is exposed. (See Conclusion 5 for more details).

One of the more striking findings of this study is that overall risks from consumption of contaminated groundwater are estimated to be low (about 1-2% of the cancer risk among the sources examined in this study, or about one additional cancer case every 15 to 30 years). Estimated cancer risks from current levels of exposure at public wells are lower: one estimated additional cancer case every 800 years. The primary reasons for this finding of relatively low risk from groundwater are that natural hydrogeologic protection and a number of regulatory programs and voluntary actions in effect or soon to go into effect are expected to limit most people's exposure. The IEMP estimates that no more than about 20% of the people in the Santa Clara Valley are likely to be exposed to groundwater contamination, compared to about 100% to air contaminants and about 50% to trihalomethanes in surface water. It is important to note that while our analysis of future groundwater contamination involves substantial uncertainties, this conclusion of relatively low health risks holds up under a wide range of alternative assumptions and appears fairly solid.

The key hydrogeologic factor is the presence of an aquitard, or clay layer, over much of the Valley protecting public drinking water sources. While this clay layer has, for the most part, prevented contamination near the surface from reaching deep drinking water supplies, there is concern that such contamination could occur either through abandoned wells that may function as conduits, or through faults in the confining layer itself. The recent discovery of deep groundwater contamination in Mountain View (which has not yet affected public drinking water wells) provides the first strong evidence of contaminant transfer through conduit wells in the Santa Clara Valley. This finding is consistent with the IEMP analysis, which suggests that conduit well transport is likely to be more significant than contamination through the major clay confining layer itself, and that a number of public wells may eventually be affected in this way.

One important set of regulatory programs estimated to reduce groundwater contamination and human exposure are the local Hazardous Materials Management Ordinances, which have become models for hazardous materials control in other areas. These ordinances reduce contamination at the source by requiring groundwater monitoring near underground tanks, improved tank construction standards, and better chemical handling processes. Other important regulatory and response actions include clean-up actions at existing contamination sites, public drinking water well monitoring for a broad range of organic chemicals (to be required annually), and a policy of closing any public well contaminated above state action levels. Voluntary actions taken by firms, such as underground tank replacement and improved handling procedures, are also likely to reduce future groundwater contamination.

Analysis of the effectiveness of all of these programs indicates that, in combination, they may reduce health risks by roughly one hundred times (e.g., risks with these programs in place may be only 1% of what risks would have been without them). Other programs, including efforts to seal abandoned wells that may act as contaminant conduits, and efforts to monitor and protect private wells, are also likely to reduce health risks from groundwater contamination.

Exposure through the outdoor air and drinking water is direct, as people take in pollutants through breathing or drinking. Contamination affecting the San Francisco Bay and local surface streams, by contrast, was judged to be only indirectly related to human exposure, largely through body contact or fish consumption. Exposure through these routes appears to be relatively small by comparison with air and drinking water exposure.

Most hazardous wastes are exported from the Santa Clara Valley for recycling or disposal elsewhere, and thus pose little local risk. Those local risks we could identify from hazardous waste storage and handling appear to be primarily through groundwater contamination, and were analyzed under that exposure pathway. Accidental releases, such as those resulting from transportation accidents, also have the potential to affect soil and groundwater.

Although the IEMP explicitly examined a number of potential issues of pollution transfer from one medium to another, none appeared to be very significant in terms of public health risk in the Santa Clara Valley. For example, the study estimated the possible toxic organic chemical air emissions from sewage treatment plants, groundwater aeration/clean-up sites, and sanitary landfills. Air emissions from these sources were estimated to be fairly small in comparison to other sources of toxic organic gases.

4. The toxic environmental contaminants posing the most significant health risks in the Santa Clara Valley are, for the most part, the same as those found in the other urban environments. A relatively small number of toxic chemicals, including the trihalomethanes (primarily in drinking water), and benzene, gasoline vapors, carbon tetrachloride, benzo(a)pyrene, chromium and arsenic (primarily in air), account for about 92% of aggregate cancer risk estimated in this study. National studies and data from other areas show that estimated exposure levels in the Santa Clara Valley are similar to, and in some cases lower than, ambient concentrations found in other urban areas. It should be noted that the less-developed southern Santa Clara Valley has a contamination problem typical of many agricultural areas: high nitrate levels in the groundwater. A summary of estimated cancer risks by pollutant is presented in Table Four.

As a class, volatile organic compounds account for the majority (about 58%) of the cancer risk estimated in this study. Heavier organic chemicals, such as benzo(a)pyrene, comprise an estimated 20% of aggregate cancer risk. Metals and inorganic substances account for about 22% of total estimated cancer risk.

TABLE FOUR

ESTIMATED INCREASE IN CANCER INCIDENCE
IN SANTA CLARA VALLEY, BY POLLUTANT

POLLUTANT (WEIGHT OF EVIDENCE)[1]	POINT ESTIMATE OF ANNUAL INCREASE IN CANCER INCIDENCE (Range)			
	All Exposure Pathways	Air	Surface Water	Groundwater
VOLATILE ORGANIC CHEMICALS				
Trihalomethanes (B2) *	1.3	<0.01	1.3	<0.01
Benzene (A)	0.3 (0.3- 1.2)	0.3 (0.3- 1.2)	<0.01	<0.01
Carbon Tetrachloride (B2)	0.2	0.2	---	<0.0001
Gasoline Vapor (B2)	0.1 (0 - 0.4)	0.1 (0 - 0.4)	---	---
1,1, Dichloroethylene	0.04	---	---	0.04
Perchloroethylene (B2)	0.04	0.03	---	<0.01
Ethylene Oxide (B1)	0.03	0.03	---	---
Other (A-C)	0.03	0.02	<0.01	0.01
TOTAL, VOCs	2.1 (1.9- 3.5)	0.7 (0.6- 1.9)	1.3	0.06 (0.03 - 0.3)
ORGANIC PARTICULATES				
BENZO(A)PYRENE GROUP (B2)	0.7 (0.01-1.3)	0.7 (0.01-1.3)	---	---
METALS AND INORGANICS				
Chromium (A) **	0.4 (0 - 4.0)	0.4 (0 - 4.0)	0	0
Arsenic (A) ***	0.3 (0.2- 7.4)	0.3 (0.2- 0.4)	0 (0-7)	***
Cadmium (B1) **	0.07 (0.04-0.1)	0.07 (0.04-0.1)	0	0
Other (A-B2)	0.03 (0 - 0.07)	0.03 (0 - 0.07)	0	0
TOTAL, METALS	0.8 (0.2-11.6)	0.8 (0.2- 4.6)	0 (0-7)	0
TOTAL, ALL CHEMICALS STUDIED	3.6 (2.1-16.4)	2.2 (0.8- 7.8)	1.3 (1.3 - 8.3)	0.06 (0.03 - 0.3)

FOOTNOTES TO TABLE FOUR

NOTE: BECAUSE OF SIGNIFICANT UNCERTAINTIES IN THE UNDERLYING DATA AND ASSUMPTIONS, THESE ESTIMATES OF DISEASE INCIDENCE ARE ONLY ROUGH APPROXIMATIONS OF ACTUAL RISK. THEY ARE BASED ON CONSERVATIVE ESTIMATES OF EXPOSURE AND POTENCY, AND ARE MORE LIKELY TO OVERESTIMATE RISKS THAN UNDERESTIMATE THEM. See text.

1 The weight of evidence of carcinogenicity for the compounds listed varies greatly, from very limited to very substantial. According to EPA's categorization of levels of evidence of carcinogenicity, A = proven human carcinogen; B1 = probable human carcinogen (limited human evidence); B2 = probable human carcinogen (insufficient human evidence but sufficient animal evidence); C = possible human carcinogen; D = not classifiable; E = no evidence.

* The weight of evidence identified for trihalomethanes is that for chloroform only.

** Neither (hexavalent) chromium nor cadmium is thought to be carcinogenic in water. See chapter 4.

*** There is some dispute over the carcinogenicity of arsenic in water. See text. Arsenic exposure listed under surface water is for combined exposure to surface water and groundwater.

Arsenic risk in drinking water is a significant question mark in this analysis. Arsenic accounts for as little as 0 to as much as 66% of total estimated cancer risk, depending on assumptions about its toxicity. Some evidence exists that arsenic in drinking water may cause a form of skin cancer known as "Blackfoot Disease." Applying EPA's standard risk estimation techniques, the IEMP would estimate up to seven additional cancer cases a year from exposure to the levels of arsenic found in Santa Clara Valley water (these levels are fairly low in comparison to those found in many areas). Substantial disagreement exists as to the carcinogenicity of low levels of arsenic in drinking water, however, and EPA's Office of Drinking Water believes that the levels of arsenic found in Santa Clara Valley water are well within safe limits. This uncertainty does not affect the estimate of lung cancer from airborne arsenic; the evidence for this effect is much stronger.

The cancer risk from chromium in the air is another significant uncertainty in this analysis. Monitoring data do not distinguish between hexavalent chromium (thought to pose a risk of lung cancer) and other forms (not considered carcinogenic). Depending on assumptions about the proportion of chromium that is hexavalent, estimated cancer risk ranges from none to four additional cases per year. Based on studies conducted elsewhere and a tentative identification of local sources, this study conservatively assumed that about 10% of airborne chromium was hexavalent.

5. The pollution sources posing the most significant overall health risks appear to be similar to high-risk sources identified in other urban areas. However, the sources of some of the most important environmental toxics are uncertain. Identifying sources is important for risk management, since pollution control decisions aimed at reducing risk must be directed at known sources of risk. Table Five presents a preliminary breakdown of cancer risk by source type, making some assumptions about the sources of chemicals whose origin is not well understood.

Most (about 77%) of the estimated risk from air exposure, particularly for the toxic metals and organic particulates, is from sources that are only tentatively identified. The AQMD does not maintain emissions inventories for the metals and organic particulates, as it does for toxic organic gases. Since consideration of control actions requires a knowledge of the sources of risk, this report has identified the collection of data on the sources and emissions of these substances as an important research need. In Stage II, the AQMD, with assistance from EPA, plans to compile a metals emissions inventory. The IEMP has done some preliminary analysis of the possible sources of many of the substances of concern. However, more definitive source identification would be required in most cases before risk management control actions can be taken.

Preliminary analysis of likely sources suggests that the primary sources of toxic chemicals in the air may be dispersed area sources, such as residential heating and motor vehicles. These sources appear to emit the bulk of the benzene, gasoline vapors, benzo(a)pyrene, and metals that are

TABLE FIVE

ESTIMATED INCREASE IN CANCER INCIDENCE
IN SANTA CLARA VALLEY, BY SOURCE TYPE

SOURCE TYPE (EXPOSURE PATHWAY) [WEIGHT OF EVIDENCE][1]	ESTIMATE OF ANNUAL INCREASE IN CANCER INCIDENCE	PERCENT OF TOTAL ESTIMATED CANCER INCIDENCE
Drinking Water Disinfection (Surface Water) [B2] *	1.3	36%
Fuel Combustion for Residential Heating ** (Air) [A-B2]	0.63 - 1.1	18-31%
Motor Vehicles (Air) [A-B2]	0.63 - 0.67	18-19%
Cement Plant ** (Air) [A-B2]	0 - 0.5	0-14%
Unknown Sources/Background Contamination (Air) [A-B2]	0.2 ***	6%
Other Area Sources (Air) [A-B2]	0.15	4%
Other Point Sources (Air) [A-B2]	0.1	3%
Underground Industrial Tanks (Groundwater) [A-C]	0.05	1%
Underground Fuel Tanks (Groundwater) [A-B]	<0.01	<1%
TOTAL, ALL SOURCES STUDIED	3.6	100%

FOOTNOTES TO TABLE FIVE

NOTE: BECAUSE OF SIGNIFICANT UNCERTAINTIES IN THE UNDERLYING DATA AND ASSUMPTIONS, THESE ESTIMATES OF DISEASE INCIDENCE ARE ONLY ROUGH APPROXIMATIONS OF ACTUAL RISK. THEY ARE BASED ON CONSERVATIVE ESTIMATES OF EXPOSURE AND POTENCY AND ARE MORE LIKELY TO OVERESTIMATE RISKS THAN UNDERESTIMATE THEM. See text.

1 The weight of evidence of carcinogenicity for the compounds listed varies greatly, from very limited to very substantial. According to EPA's categorization of levels of evidence of carcinogenicity, A = proven human carcinogen; B1= probable human carcinogen (limited human evidence); B2 = probable human carcinogen (insufficient human evidence but sufficient animal evidence); C = possible human carcinogen; D = not classifiable; and E = no evidence.

* Chloroform is considered a probable carcinogen. The upper end of this range reflects the possibility that other THMs are also carcinogenic. See chapter 4.

** Source identification for residential heating and cement plant is preliminary and uncertain. See chapter 3.

*** This point estimate derives from an estimated range of 0.2 to 7.4 annual incidence. The point estimate does not include the potential risk from arsenic in drinking water. There is substantial disagreement as to the carcinogenicity of low levels of arsenic in drinking water. Conservative assumptions of carcinogenicity, developed by EPA's Office of Research and Development, suggest that the levels found in the drinking water in the Santa Clara Valley could result in up to 7.2 additional cases per year. However, EPA's Office of Drinking Water, which is responsible for setting standards, believes that low levels do not pose risk.

projected to cause most of the air toxics risk. Industrial point sources do not appear to be significant contributors to aggregate risk, with the possible exception of the coal-burning cement plant. This pattern of many small and dispersed sources suggests that it may be difficult to control major contributing sources so as to reduce risk.

Surface water risks are dominated by hazards posed by trihalomethanes resulting from water disinfection. The presence of trihalomethanes in treated drinking water involves a trade-off of one form of risk for another: while chlorination introduces chloroform and other potential carcinogens into drinking water supplies, it protects the population from the otherwise much greater risk of infectious diseases such as cholera and typhoid.

Although discontinuing disinfection is not a viable option, there are other disinfection methods that reduce the formation of trihalomethanes. The Santa Clara Valley Water District (SCVWD) has recently implemented one such treatment method, chloramination, at its two major local water treatment plants. The IEMP projects that this change may reduce potential risks substantially. In addition, the SCVWD has recently commissioned a study of still other disinfection techniques, such as ozonation, that might reduce risks further. Given the apparent importance of these chlorinated organic chemicals relative to other sources of toxic health risk, such analysis of alternatives may be appropriate, both in the Santa Clara Valley and elsewhere.

"Background" contamination is contamination not linked to any known current source. Such contamination may be from natural sources, such as minerals in the soil, or from prior agricultural or industrial activities. Background contamination, largely from persistent levels of carbon tetrachloride in the air, is estimated to account for about 5% of total cancer risk from sources and pollutants studied. However, if pessimistic assumptions about the carcinogenicity of arsenic in drinking water are correct, the risk from background contaminants increases to well over half of all estimated cancer risk in the Santa Clara Valley.

The major groundwater contamination sources examined, underground fuel and solvent tanks, are estimated to account for about 1-2% of the total cancer risk among sources examined.

6. Some individuals, who live near pollution sources or are highly exposed for other reasons, face toxic health risks that appear to be significantly higher than average. Estimates of potential risk to these most-exposed individuals (MEIs) are shown in Table 6.

In contrast to the estimates of low overall risks from groundwater contamination, people drinking from private wells appear to be vulnerable to potentially significant levels of exposure and risk as a result of leaks from underground tanks. Individuals who obtain drinking water from private wells are more vulnerable to risk because these wells are shallow (and thus not protected from surface contamination by an intervening clay layer) and are not typically monitored. Risks to individuals who may be

TABLE SIX

ESTIMATED HEALTH RISK TO MOST-EXPOSED INDIVIDUALS IN SANTA CLARA VALLEY

EXPOSURE PATHWAY & SOURCE TYPE	INCREASED LIFETIME CANCER RISK (CHANCES IN A MILLION) [1]	POLLUTANT (WEIGHT OF EVIDENCE) [2]	POTENTIAL NON-CANCER HEALTH EFFECTS [3]
AIR:			
TRAFFIC INTERSECTIONS	300	Benzene (A)	Blood, fetal
		Benzo(a)pyrene(B2)	---
		Cadmium (B1)	---
		Ethylene Dibromide(B2)	---
HOSPITALS	200	Ethylene Oxide (B1)	---
PHARMACEUTICAL MANUFACTURER	100	Ethylene Oxide (B1)	---
COMPUTER EQUIPMENT MANUFACTURER [4]	40	Benzene (A)	Blood, fetal
		Methylene Chloride (B2)	
INDUSTRIAL FACILITY [4]	30	Methylene Chloride (B2)	---
		Benzene (A)	---
			*
FUEL PIPELINE	20	Benzene (A)	---
DRY CLEANERS	10	Perchloroethylene (B2)	---
SEWAGE TREATMENT PLANTS [4]	5	Chloroform (B2)	---
		Benzene (A)	---
		Methylene Chloride (B2)	---
		Perchloroethylene (B2)	---
		Trichloroethylene (B2)	---
GAS STATION PUMP	4	Benzene (A)	---
		Gasoline Vapors (B2)	
GROUNDWATER AERATION [4]	0.2	Methylene Chloride (B2)	---
		Trichloroethylene (B2)	

TABLE SIX (cont.)

ESTIMATED HEALTH RISKS TO MOST-EXPOSED INDIVIDUALS IN SANTA CLARA VALLEY

EXPOSURE PATHWAY & SOURCE TYPE	INCREASED LIFETIME CANCER RISK (CHANCES IN A MILLION)[1]	POLLUTANT (WEIGHT OF EVIDENCE)[2]	POTENTIAL NON-CANCER HEALTH EFFECTS[3]
GROUNDWATER:			
UNDERGROUND TANKS [5] (AT PRIVATE WELLS)	20,000	1,1 Dichloroethylene (C)	Liver, kidney,
		Vinyl Chloride (A)	Liver, kidney, cardiovascular
		Perchloroethylene(B2)	—
		Ethylene Dibromide (B2)	—
		Methylene Chloride (B2)	Liver, fetal
		Chloroform (B2)	—
		Benzene (A)	6
		Trichloroethylene (B2)	Liver, neurobehavioral
		1,1,1-Trichloroethane	Liver, neurobehavioral *
FERTILIZER, SEPTIC TANKS	—	Nitrates	Methemoglobinemia (Blue baby syndrome)
SURFACE WATER:			
DRINKING WATER TREATMENT	100**	Trihalomethanes (B2)	—
BACKGROUND	0 - 7,000***	Arsenic (A)	—
SOUTH SAN FRANCISCO BAY:			
SHRIMP CONSUMPTION [7]	0 - 6,000***	Arsenic (A)	—
MUSSEL CONSUMPTION [7]	20 - 200	PCB (B2)	—
		Chlordane (B2)	—
		DDT (B2)	—
STRIPED BASS CONSUMPTION [7]	80 - 16,000	PCB (B2)	Liver, neurobehavioral, kidney, reproductive
		Cadmium	Kidney, reproductive, liver, birth defects
		Mercury	8

FOOTNOTES TO TABLE SIX:

NOTE: BECAUSE OF SIGNIFICANT UNCERTAINTIES IN THE UNDERLYING DATA AND ASSUMPTIONS, THESE ESITMATES OF INDIVIDUAL RISK AND DISEASE INCIDENCE ARE ONLY ROUGH APPROXIMATIONS OF ACTUAL RISK. THEY ARE BASED ON CONSERVATIVE ESTIMATES OF EXPOSURE AND POTENCY AND ARE MORE LIKELY TO OVERESTIMATE RISKS THAN UNDERESTIMATE THEM. See text.

1 Except in the case of underground tanks at private wells, estimated cancer risk is for all pollutants combined from given source. For underground tanks, estimate is for pollutant posing the greatest cancer risk. In each case, pollutants for each source are listed in decreasing order of estimated cancer risk.

2 The weight of evidence of carcinogenicity for the compounds listed varies greatly, from very limited to very substantial. According to EPA's categorization of levels of evidence of carcinogenicity, A = proven human carcinogen; B1 = probable human carcinogen (limited human evidence); B2 = probable human carcinogen (insufficient human evidence, but sufficient animal evidence); C = possible human carcinogen; D = not classifiable; E = no evidence.

3 Non-cancer health effects are reported only if exposures are above estimated thresholds for such effects.

4 If TCA is assumed to be carcinogenic, total estimated cancer risk is at or slightly above level presented.

5 Estimated impacts are for "high" release, base case; see chapter 4.

6 Estimated taste and odor threshold is very slightly below the estimated threshold for blood effects.

7 Estimated risks for fish consumption are for a hypothetical individual who regularly consumes contaminated fish or shellfish caught in the South Bay. Assumed consumption is 5 to 52 pounds of fish per year. Note that the IEMP has no actual data on the number of people eating fish from the South Bay, although we believe that number is small.

8 Estimated exposure value for mercury in striped bass is just slightly under the lowest estimated human threshold.

* The IEMP conducted sensitivity analysis on TCA for possible fetal effects. See footnote to text.

** Risk for system with highest estimated average risk; some individuals may be exposed to higher risks.

*** Considerable controversy exists as to the carcinogenicity of arsenic by ingestion. See text.

highly exposed to industrial chemicals in their private wells were estimated to be potentially higher than risks from any other source examined. The estimated risk to the most-exposed individual drinking from a private well is quite uncertain and should not be interpreted literally. However, the potential vulnerability of this group is clear, and this is the important conclusion for risk management. Current efforts by the County Health Department to monitor some private wells appear to be a useful first step in addressing this problem.

Persons living near a highly congested intersection were estimated to face the highest individual cancer risk from exposures to toxic air contaminants such as benzene. The risk facing individuals living near hospitals and exposed to the sterilant ethylene oxide (ETO) was estimated to be nearly as large. These potential risks from high exposures to air toxics are substantially lower than the estimated risks for highly exposed individuals at private wells. The comparatively high estimated risk near intersections reinforces the importance of vehicles as a source of air toxics risk - both to the general populace and to highly exposed individuals. Ethylene oxide from hospitals, on the other hand, is not projected to be a major source of risk for most people but nevertheless appears to pose comparatively high risks near the source. Because of uncertainties about ETO emissions, and the possible reactivity of the chemical once released, estimated emissions and exposure levels should be confirmed before control actions are taken. Since use of ETO as a disinfectant is not unique to the Santa Clara Valley area, this finding, if confirmed, may have implications for other areas.

Although we lack actual consumption data, estimated risks to a hypothetical individual regularly consuming significant quantities of contaminated fish or shellfish caught from the South San Francisco Bay appear to be fairly high. Concentrations of PCBs, pesticides, mercury, and other metals in shrimp, mussels, and striped bass may pose a significant risk. Possible effects include cancer, neurobehavioral, reproductive, kidney, and liver effects (estimated thresholds for non-cancer effects are exceeded only under a "high" consumption estimate of one pound per week of contaminated fish). We stress that these exposure estimates are conservative, and that we have no data on the number of people consuming contaminated fish from the South Bay. Nevertheless, these estimates suggest that regular consumption of fish or shellfish from the South Bay may pose significant health risks. This finding is consistent with a health advisory issued by the state Department of Health Services, warning pregnant women not to eat striped bass.

7. One of the more important implications of this analysis is that groundwater contamination may be an economic and natural resource issue as well as a risk issue. IEMP estimates of future risk depend on many actions that we assume will be taken in the future. For example, the study assumes that public drinking water wells will be closed when contaminated above action levels and replacement supplies obtained; it also assumes that the Hazardous Materials Management Ordinances will be implemented, although this has not yet fully occurred. While IEMP projects

that these actions will be largely successful in controlling risk, they could be extremely expensive. The direct economic costs of contamination prevention and response include the costs of tank replacement, clean-up, monitoring and well closure. In addition, groundwater contamination causes a potentially significant indirect natural resource cost: the loss of clean, local groundwater.

The IEMP analysis illustrates the difference between drinking water health risk and groundwater resource impacts. Under the rather pessimistic assumptions used in this study, health risks to people drinking groundwater from public wells are projected to be comparatively small. Yet, about 55 public wells serving 139,000 people are projected to be affected by fuel or industrial contamination, with one quarter to one half of the wells contaminated above state action levels.

Contamination above action levels requires well closure or treatment. In some cases, contamination below action levels has also led to removing a well from service. Clean-up of contaminant plumes can also have a significant impact on the groundwater resource, as large quantities of groundwater are pumped, cleaned and discharged to the Bay. This water must be replaced with recharge water imported from the Sacramento Delta. While the IEMP estimates of the number of wells likely to be affected are intentionally pessimistic, they clearly indicate the importance of examining the natural and economic resource impacts, as well as the health effects, of groundwater contamination and programs to address it.

Thus, the low aggregate risk estimates presented in this draft report do not imply that groundwater contamination is not an important environmental management issue. Despite the comparatively low estimated aggregate risks, it may be appropriate to assess groundwater control and treatment options in terms of their potential risk, cost, and resource impacts.

8. <u>This study identified many scientific uncertainties and data gaps that may be appropriate research priorities for regulatory agencies or others.</u> A few of the most important include:

- Hydrogeology: A better understanding of Santa Clara Valley hydrogeology - in particular the effectiveness of the major clay confining layer or aquitard - would improve the ability to protect the groundwater resource effectively.

- Pollutant transport and transformation: In particular, better understanding of the speed with which fuel contaminants degrade after release into the environment is critical to determining the importance of leaking fuel tanks as a groundwater contamination source.

- Monitoring data: Two of the more critical uncertainties in this Stage I analysis - levels of organic chemicals in the ambient air and in private wells - are being addressed by local agencies. Local data on organic particulates in air would be valuable also; the IEMP plans to sponsor the collection of such data as a part of Stage II.

- Source data: Better information on sources of metals and organic particulates in air is needed to assist in the development of risk management strategies. The Bay Area Air Quality Management District, with EPA support, will be compiling a metals emissions inventory in Stage II.

- Non-Cancer effects: Development of a method of estimating possible disease incidence for effects other than cancer would allow a more complete analysis of toxic health risks. Some key chemicals of concern in the Santa Clara Valley have been identified in this report. These issues are being pursued within EPA and by scientific peer review groups.

Next Steps

This Stage I Report for the Santa Clara Valley Integrated Environmental Management Project presents the results of the IEMP's comparative analysis of toxic environmental health risks. Potential health effects were analyzed, and exposure pathways, pollutants and sources compared in terms of health risk. A draft of this report has been reviewed widely by EPA's two advisory committees, the Intergovernmental Coordinating Committee and the Public Advisory Committee, and by other interested agencies, scientists and individuals. It is now undergoing scientific peer review by a group of scientists at Rutgers University.

The Stage I Report findings are intended to provide the basis for Stage II of the IEMP, which will focus on managing risks: identifying priority issues, analyzing control options for dealing with those problems, and implementing solutions. Stage II will also expand and improve upon the problem definition developed in Stage I.

EPA, in consultation with its IEMP advisory committees, has developed a Stage II workplan to guide the project's future work. This workplan identifies risk management priorities, taking into account public concerns and ongoing programs. It outlines research priorities, analyses of pollution control options, and a management strategy that EPA and its local partners hope will lead to discussions and actions that protect public health and the environment more effectively.