Projecting Hazardous Materials and Wastes in Transportation: Conceptual and Methodological Factors and Application

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Future quantities and routings of hazardous materials shipments were projected for the year 2000, on the basis of the results of previous Arizona transportation surveys. Projections were made of internal shipments of gasoline, propane, and acids. Interstate shipments, hazardous waste, and nonbulk shipments were also projected. Routing maps of Arizona depicting the projected shipments were then created. A data base information system was developed to store hazardous waste shipment data for the year 1986, and information from this data base was used to project volumes and routings of these shipments. Despite the uncertainties, the effects of new regulations and waste minimization activities were incorporated. Similar projection routing maps were developed for hazardous materials. The results provide a picture of future hazardous materials transportation on Arizona highways and a basis for conducting risk analysis. Methodological issues and data availability problems are addressed to model projections at the state level.

Approaches used to project hazardous materials shipments and routing patterns in the state of Arizona are described. The projections are based on a 1985 study (*1–3*) of the movement of hazardous materials in Arizona, and further analysis of available transportation data subsequent to the initial study. However, the 1985 statistics serve as a baseline for the projection of shipments in the year 2000.

States have been increasingly interested in developing an understanding of the volumes and types of dangerous substances that are transported within their jurisdictions. Some of this interest is related to the need for information to enhance hazardous waste management. Also, this interest reflects the need for information to help in more effective planning in the area of hazardous materials transportation accidents. Several states and cities have recently undertaken surveys of hazardous materials transportation patterns to conduct risk analysis for routing decisions.

Projections of hazardous materials shipments and routing are difficult, and are based on assumptions with high levels of uncertainty. First, for most states the available data bases are not comprehensive for the entire road network nor do they include the full range of hazardous materials. Second, the available data bases are derived from sample surveys that may have serious projection limitations, because of dubious generalizability. The additional problem of many of these surveys (including the 1985 Arizona survey) is that they do not provide trend data; the data characterize hazardous material shipments for one point in time. As a result, projections, by necessity, depend on indirect methods (such as using regression analysis that indicates a relationship between hazardous materials volume and projected growth within a sector of the economy).

Although several studies have attempted to estimate current shipment levels of hazardous materials, no other investigations have been found that try to develop an approach that characterizes the full range of shipments on a route-by-route basis, that is, of statistical significance that can be generalized to the state as a whole. Forecast assumptions for each category of hazardous substances in transportation—hazardous waste, through-traffic interstate shipments, intrastate bulk chemical shipments, and hazardous materials entering the state—are also developed. A systematic approach is used that is comprehensive in scope, that has attempted to reduce the uncertainties identified, and that can serve as a model for other states' hazardous materials shipment forecasts.

Projections of hazardous materials shipments were accomplished by examining assumptions in four distinct areas of hazardous materials transport. The first area consisted of examining the intrastate shipment patterns of bulk hazardous goods, which included gasoline, propane, and acids. Based on the 1985 baseline study and changes to date, assumptions were developed for each bulk product and projections made for the year 2000. For each group of hazardous material, projected routing patterns were determined.

The second component of hazardous materials shipments for which projections were undertaken was the through-traffic shipments. These shipments refer to vehicles that enter the state, do not unload their cargo, and exit the state. Over 50 percent of hazardous materials shipments that enter Arizona are through-traffic shipments. The third component involves the nonbulk hazardous materials shipments that enter Arizona for industrial and agricultural processing. The expansion of this category is related to growth in the sectors of the economy that use these materials.

The fourth area of attention focuses on the pattern of transporting hazardous waste, which falls under the authority of the Resource Conservation and Recovery Act (RCRA). In projecting hazardous waste shipments, shipment data were collected for 1983 through 1986, including survey efforts.

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Three factors will significantly affect the volume of waste to be transported from the state in the future:

1. Continuous growth of the high technology industry in the state (which is a major generator of hazardous waste),
2. Efforts at hazardous minimization and recycling, and
3. Implementation of the small-quantity hazardous waste generator regulations.

A substantial amount of uncertainty is associated with these factors. Consequently, the projections of hazardous waste shipments were built around three scenarios of possible eventualities.

INTERNAL SHIPMENTS OF BULK HAZARDOUS MATERIALS: PROJECTION ASSUMPTIONS

The three major subclasses of bulk shipments are gasoline, propane, and acids. The sum of these three bulk commodities constitutes more than 80 percent of all the internal bulk shipments of hazardous materials on Arizona highways. The goal was to project the volume and routings of gasoline, propane, and acids on the major highway routes within Arizona for the year 2000.

Gasoline shipments originate in Phoenix and Tucson gasoline tank farms (to which gasoline is brought from neighboring states by pipeline and stored before distribution) and end at different gas stations inside the state. To forecast gasoline sales for the target year, correlation analysis of historical gasoline sales data with key socioeconomic factors was undertaken. Historical data of gasoline sales were obtained from the Motor Vehicle Division of the Arizona Department of Transportation (ADOT), and three socioeconomic variables—automobile registration, population, and employment data that were obtained from the Arizona Department of Economic Security (ADES). Data were secured for the county level and regression analysis was conducted separately for each of the three socioeconomic factors with gasoline sales data. The best relationship for gasoline sales was observed to be with population. Therefore, 15 linear regression equations were developed for the 15 counties in Arizona, and county population forecasts were used in these equations to project gasoline sales.

Gasoline shipments from Phoenix and Tucson to the various smaller communities in Arizona are done by 8,500-gal tank trucks. There are some Arizona border communities whose gasoline needs are met by out-of-state shipments rather than by shipments from the tank farms. These are basically the communities that lie on or near the major highway routes like I-40, I-10, and I-8, and the state's ports of entry. To incorporate this feature in the projection, the volumes of projected gasoline sales were adjusted by a factor derived from the population that will be served by the domestic tank farms. After this adjustment was made, projected gasoline volumes were converted from gallons to number of truckloads. Once the number of truckloads to each of the counties and communities was established, their respective routes from Phoenix or Tucson to those communities were defined. During the 1985 study, a survey of truck drivers was conducted to ascertain the preferred truck routes in Arizona. The results of this survey and engineering judgment were used in assigning the projected routes. Special care was taken for counties that are equidistant from Phoenix and Tucson. They were divided into regions, depending on proximity and accessibility from Phoenix and Tucson.

Propane is brought into Arizona mainly from Gallup, New Mexico, and partly from Anneth, Utah. Although some of the propane shipments to the in-state distribution centers are carried by railroad, most are by tank trucks on major highways originating in the northeast region. They are then distributed to the retail shops in smaller bulk shipments.

Propane suppliers were contacted for information on their monthly shipments. The number of shipments originating from out-of-state locations and destined to distribution centers in Arizona was identified. Furthermore, shipments originating from distribution centers and destined to companys' retail plants in Yuma, Chandler, Glendale, and other communities were also identified, including the primary routes over which propane shipments are transported.

Projected propane consumption data are not readily available. A report published by the Department of Energy (DOE) documented national energy pricing and consumption trends. The following facts, that have relevancy to the projection analysis, were noted from this report. The price of oil is expected to remain stable in the 1980s. After 1990, however, the price is expected to increase at the rate of over 4 percent per year. The price of natural gas is expected to follow the same trend as gasoline until the beginning of the 1990s. In the late 1990s, the price of natural gas will rise again and will increase every year at the same rate as oil. The history of natural gas in the United States shows a declining trend and is expected to decline rapidly from the late 1980s onward.

From this information, and by assuming that Arizona generally follows national trends in this area, the consumption of propane and other natural gases used by the residential, commercial, and industrial sectors is expected to increase (considering 1984 as the base year) slightly every year until mid-1990, and then decrease after the turn of the century. The consumption figures for gas in quadrillions of BTUs in the year 2000 is expected to be the same as in 1988. Thus, the volume and pattern of propane distribution in 1988 can be assumed to be the same as the projected propane volumes.

An indirect approach was used for the projection of bulk shipments of acids for the year 2000. Acids are generally used by the high-technology manufacturing industries, mining industry, and utilities. Because acids are not manufactured in Arizona, they are imported from outside the state and are stored in warehouses in the Phoenix and Tucson areas for further distribution to individual companies, or are transported directly to individual mines or large industries. For the purpose of projecting acid consumption in the year 2000, it was necessary to estimate the growth of these industries. Arizona has experienced a rapid growth in the area of high-technology industries. ADES periodically projects the employment level in various sectors of the economy such as manufacturing, construction, mining, and services. Figures 1 and 2 show the projections for the manufacturing and mining sectors. High-technology industries, which are included in the general group of manufacturing, can be assumed to grow in the near future at a high rate until at least the turn of the century. The mining industries, on the other hand, are expected to decline, and the utilities industries are expected to expand because of the projected growth in population of the state.

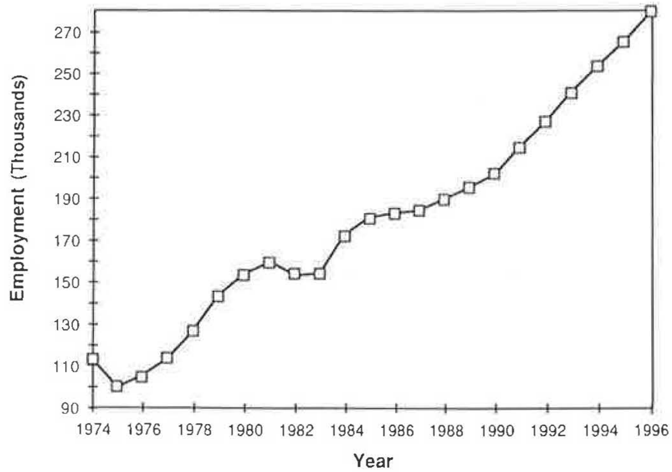

FIGURE 1 Projection of employment in Arizona in manufacturing.

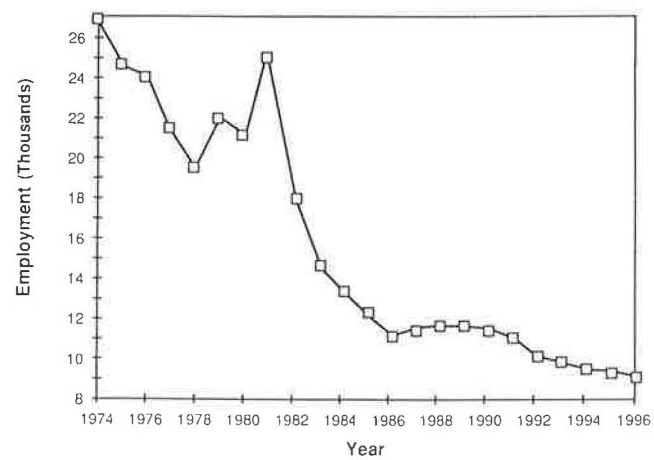

FIGURE 2 Projection of employment in Arizona in mining.

From the previous discussion, it can be assumed that the consumption of acids in the future is expected to grow, although not at as high a rate of growth as the manufacturing sector or the state population. The future volume of acids consumption can be studied under such circumstances by constructing a scenario using the trend data on economic variables. No major geographical shifts in concentration of population and industries are expected up to the year 2000. Therefore, the routings of acid shipments identified in the base year (1985) are not expected to change by the projection year.

ASSUMPTIONS FOR THROUGH-TRAFFIC AND NONBULK TYPE SHIPMENTS

Two surveys of hazardous materials carriers at the entry points into Arizona were conducted during the 1985 study (*3*). The results were used to determine the annual number of truckloads carrying hazardous materials entering Arizona. Information on the hazard class of the shipments and destinations was also collected. This information was used to estimate the number of trucks that enter but also exit without unloading, i.e., through-traffic type. Table 1 presents the statistics of that survey. However, the results depicted are not the typical ones, because during the time of the surveys the gasoline tank farms at Phoenix and Tucson were shut down and the demand for gasoline and related materials was met by imports by trucks from neighboring states. The flammable and combustible materials shipments disrupt the normality of the statistics. Under normal circumstances, most of the gasoline supply (approximately 80 percent) would have originated from the internal tank farms (some of the border communities are served by neighboring states). Table 2 presents the hazardous materials shipment figures, after adjusting for the gasoline shipments. The results show that 56 percent of the trucks that enter Arizona also exit directly without unloading.

Because almost all entering or through-traffic materials are used by the industrial sector of the economy, these volumes

TABLE 1 THROUGH-TRAFFIC HAZARDOUS MATERIAL TRUCKLOADS BY HAZARD CLASS, 1985

Hazard Class	Entering Arizona	Through-traffic	Unloading	Percent Remaining
Flammables and combustibles	82,940	27,248	55,692	67.2
Oxidizers	3,796	2,964	832	21.9
Corrosives	22,048	13,260	8,788	39.8
Poisons	3,900	2,652	1,248	32.0
Radioactives	572	572	0	0.0
Explosives	5,876	4,992	884	15.0
Total	119,132	51,688	67,444	56.6

are expected to grow in the future at approximately the same rate as the industries that use them. Assuming an annual industrial growth rate of 4 percent for the region (based on ADES forecasts) and taking the 1985 shipment data as the base, the hazardous materials volumes should grow by about 1.8 times by the year 2000. The projected annual hazardous materials shipments by hazard class are presented in Table 3. The projected nonbulk-type shipments, i.e., oxidizers, explosives, radioactives, and poisons, are also presented in Table 3.

Final results of the gasoline shipments routing allocation were drawn on a route map of Arizona (Figure 3). This projection map shows the number of gasoline shipments in tank trucks on various segments of Arizona's highway system network. Projected volumes of propane and its shipment routings are shown in Figure 4. Using projected volumes and routings of acid shipments, a similar projection map was prepared (see Figure 5). Projections of shipment routings of nonbulk-type hazardous materials, i.e., oxidizers, poisons, explosives, flammables, combustibles, and radioactives, were also developed.

PROJECTIONS OF HAZARDOUS WASTE SHIPMENT

The movement of hazardous wastes is monitored by a manifest system that requires generators and transporters to report

TABLE 2 THROUGH-TRAFFIC HAZARDOUS MATERIAL TRUCKLOADS AFTER ADJUSTMENTS FOR GASOLINE SUPPLIES, 1985

Hazard Class	Entering Arizona	Through-traffic	Unloading	Percent Remaining
Flammables and combustibles	55,940	27,248	28,692	48.7
Oxidizers	3,796	2,964	832	21.9
Corrosives	22,048	13,260	8,788	39.8
Poisons	3,900	2,652	1,248	32.0
Radioactives	572	572	0	0.0
Explosives	5,876	4,992	884	15.0
Total	92,132	51,688	40,444	43.8

TABLE 3 PROJECTED THROUGH-TRAFFIC HAZARDOUS MATERIAL TRUCKLOADS BY HAZARD CLASS FOR YEAR 2000

Hazard Class	Entering Arizona	Through-traffic	Unloading
Flammables and combustibles	100,100	48,450	51,650
Oxidizers	6,850	5,350	1,500
Corrosives	39,700	23,900	15,800
Poisons	7,000	4,750	2,250
Radioactives	1,000	1,000	0
Explosives	10,600	9,000	1,600
Total	165,250	92,450	72,800

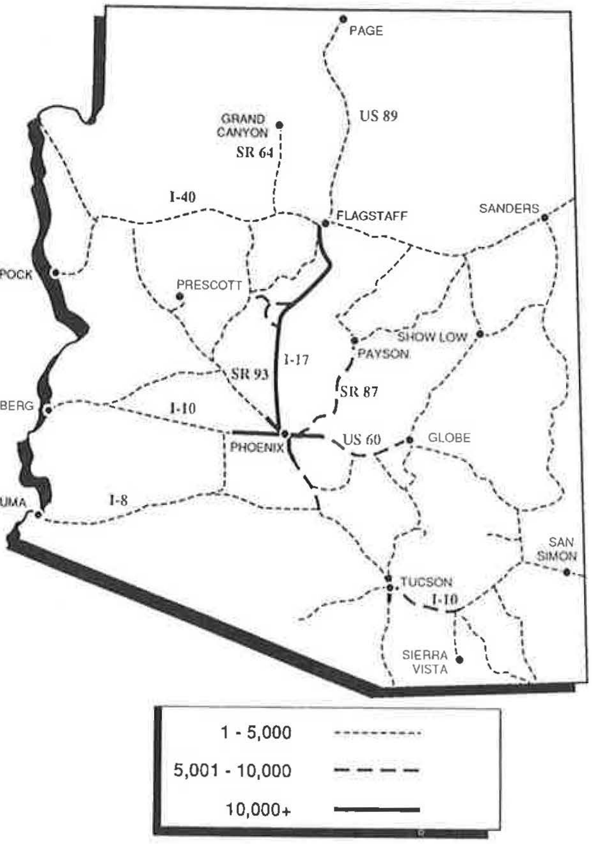

FIGURE 3 Annual truckloads of internal shipments of gasoline in Arizona for the year 2000.

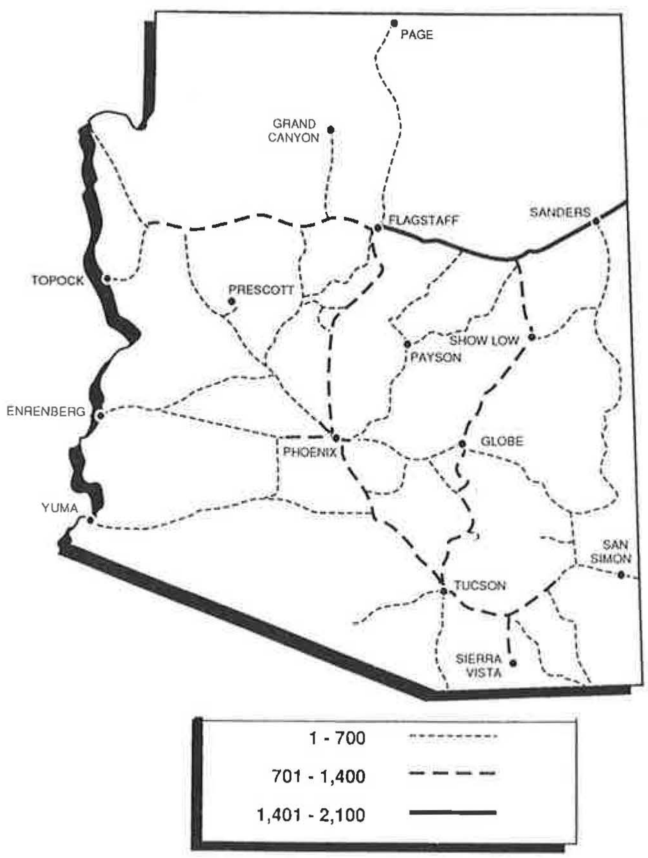

FIGURE 4 Propane shipments in Arizona for the year 2000.

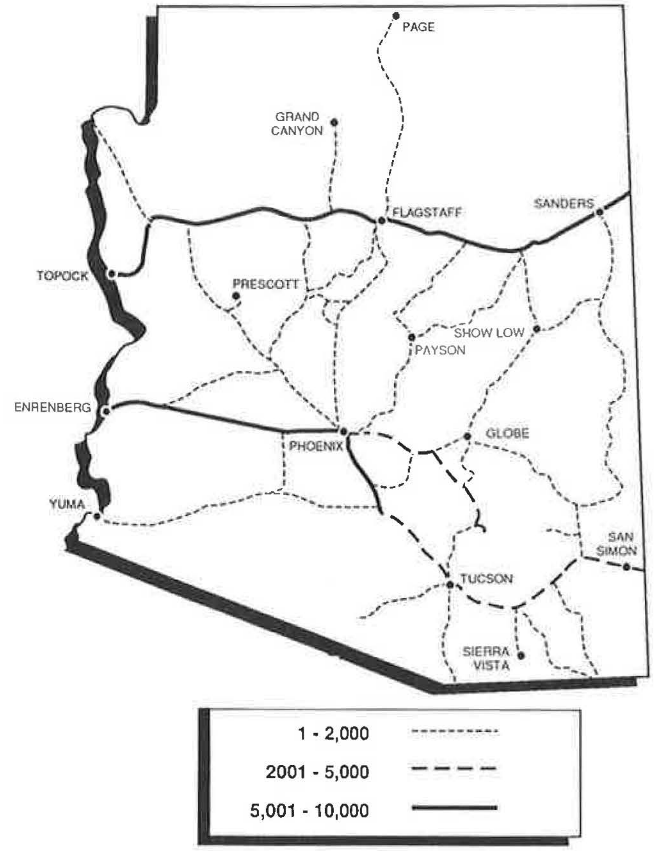

FIGURE 5 Annual truckloads of acid shipments in Arizona for the year 2000.

information. This information includes the amount and type of wastes, and U.S. Environmental Protection Agency (EPA) identification numbers of the generators, transporters, and final destination sites.

In the state of Arizona, the manifests are sent to the hazardous waste section of the Arizona Department of Environmental Quality (ADEQ) after they are completed by the transporters and generators. Most of the hazardous waste generators are concentrated in and around the urban areas of Phoenix and Tucson. The disposable wastes are typically transported to nearby states that have disposal facilities, such as California, Texas, Nevada, and Utah, as there are no disposal sites presently in Arizona. Three land disposal sites in California, one in Nevada, and one in Utah are most used by Arizona's generators and transporters. A large percentage of waste is first sent to storage and treatment facilities in Arizona before being shipped outside the state. Most of the transporters are based in Arizona or are branches of multistate corporations.

The amount of hazardous wastes transported has been on the increase in the last decade. Also, the costs of handling, storage, and disposal have increased significantly. The regulations have now become stringent regarding the types and amounts of wastes generated and disposal procedures. In addition, many generators are now compelled to reuse wastes or change the industrial processes and raw materials involved to achieve lower volumes of hazardous wastes (*4*).

The 1985 study (*1–3*) conducted for ADOT was used as a base for hazardous waste projections. For the purposes of this study, information on all of the hazardous waste shipments

for the years 1983 and 1984 was collected from the RCRA manifests filed with ADEQ, compiled, and stored in a data base management system in a dBASE III environment. This type of data base was the first of its kind in the United States and is helpful for studying such characteristics as the types and amounts of hazardous wastes usually produced, the major generators, transporters, and final destinations. Also conducted during this study was a survey of truckers, requesting them to answer questions regarding preferred routes from various origins to destinations. This aided in identifying the major routes of hazardous waste shipments.

Waste Generation Minimization and Recycling

Hazardous waste management has become a national issue and managing hazardous wastes to avoid adverse effects on health and environment is a complex problem. There are several strategies available today to prevent and reduce exposure to hazardous wastes. One strategy involving waste reduction was assessed by the National Research Council (*4*). Two reduction measures that are pertinent to this study are reduction in waste generation at the source, and recycling of wastes for energy or as raw material, or both. Reliable estimates on future shipments of hazardous wastes will be based on understanding the extent of waste reduction over the next decade.

Factors affecting hazardous waste reduction can be put broadly into two groups—nontechnical (institutional) and technical. The former factors include access (or lack of access) to information on how to reduce the generation of hazardous waste, access (or lack of access) to funds for capital investment in new equipment, predictability (or lack of it) of government regulation, and economic goals that determine the actions of industrial companies. The latter includes using different raw materials, modifying production processes, or redesigning products. There are a number of industrial processes generating waste and the technical approaches to hazardous waste generation reduction are many and varied. Numerous case studies are currently available that document the implementation and attendant benefits of such techniques by industries in the United States. The term "hazardous waste reduction" refers not only to in-plant process modifications that reduce the volume or degree of hazard of the waste generated, but also to reuse or recycling of the waste. Although reduction of hazardous waste generation is almost always possible, the amount of waste generated that can be avoided is, unfortunately, not known because of difficulties in obtaining reliable data.

Small-Quantity Generators in Arizona

In the United States, the RCRA obligates every hazardous waste generator to report the quantities of hazardous waste generated and shipped. Only small-quantity hazardous waste generators were exempted from this reporting procedure. The process of designation of small-quantity generators has seen some changes in this decade. In 1980, the EPA promulgated the small-quantity generator exemption for industries generating less than 1,000 kg/month. This action was followed by nationwide opposition because of the dangerous properties of the substances involved. Congressional hearings and legislation resulted in a law in November 1984 that reduced the limit to 100 kg/month. This regulation resulted in the need for additional disposal capacity on the part of the generators and created greater volumes of hazardous waste for transport to disposal sites.

In 1984, a survey of generators was conducted in Arizona (*5*) regarding the amounts and types of small-quantity hazardous wastes, on-site and off-site handling, and storage and disposal methods. The total number of individual firms in the survey was 4,332 and 16 percent of the total (698) were selected for the survey. Of these 698, only 409 (50 percent) reported generating hazardous waste. Some of the major industrial groups were printing and publishing, automotive repair shops, automotive paint shops, gasoline service stations, laundry and cleaning establishments, medical products, petroleum and rubber products, and electrical and communication equipment. The hazardous waste generated by these industries range from halogenated solvents, waste oils and paints, ignitable and reactive wastes, to pesticides, waste ink, and heavy metals. Four major groups of industries were found to be consistently producing hazardous waste at an average rate of more than 100 kg/month each. They were automotive repair shops, automotive paint shops, metal stamping, and gasoline service stations. It was estimated that around 3,385 firms in Arizona were producing hazardous wastes and about 1,424 of them (42 percent) fell in the four groups mentioned.

Data Collection and Analysis

To project the hazardous waste volumes and shipments, it was necessary to have a clear picture of the present situation. A few changes have evolved since the 1985 study (*1–3*). First, the lower limit amount of hazardous waste generated per month allowed for exemption from regulation has been lowered. This change results in greater volumes of hazardous wastes that must be transported to disposal sites. Second, some chemicals classified as hazardous waste have now been declared forbidden, i.e., they cannot be dumped at disposal sites. Third, the cost involved in handling, storage, and disposal of hazardous wastes has increased. The result is an unprecedented increase in waste minimization and recycling activities. This trend is expected to continue as regulations become more stringent.

Because the new laws regulating the types and amounts of hazardous wastes were passed in late 1984, it was expected that their effects would be noticeable from 1986 onwards. Therefore, it was decided to include hazardous waste shipment data from the RCRA manifests for the year 1986 (the most complete year available) to study the present hazardous waste transportation characteristics. The data gathered from the manifests were transferred to a dBASE III data base management system environment similar to the one developed during the 1985 study (*1–3*). Once the data were stored, a main program and set of programs in dBASE III language were developed that allowed the user to request selective information from or edit the data base of hazardous waste shipments of 1986. These programs were used for calculating the shipments in terms of volumes and number of shipments by hazard class. The same set of programs was then altered to obtain similar information from the hazardous waste data bases of 1983 and 1984. The percentages of total number of

waste shipments for each hazard class were estimated and are presented in Table 4.

The total volumes of hazardous waste transported for the years 1983, 1984, and 1986 are 44, 40, and 30 millions of pounds, respectively. The number of shipments in 1986 increased over the numbers reported in the years 1983 and 1984. However, the results also indicated that there has been an overall decrease in the total volume of hazardous wastes transported. The increase in the number of shipments results from the new regulations regarding the lowering of the monthly limit of hazardous waste generation for small-quantity generators. The increase in total shipment volume because of the inclusion of the waste from small-quantity generators is much smaller than the decrease resulting from hazardous waste minimization, recycling, and the use of alternative industrial processes. There is an expectation of a decreasing trend in hazardous waste transportation in the near future. Tables 5 and 6 present statistics on the applications of hazardous waste generation minimization programs in Arizona.

Projection of Hazardous Wastes

The number of hazardous waste shipments in the near future may be lowered because of recycling and waste minimization efforts. The EPA is expected to be regularly passing new

TABLE 4 PERCENTAGE OF TOTAL NUMBERS OF HAZARDOUS WASTE TRUCKLOADS BY HAZARD CLASS, 1983, 1984, AND 1986

Hazard Class	1983	1984	1986
ORM-E	28.3%	29.2%	28.1%
Flammables and combustibles	37.6%	40.7%	36.2%
Corrosives	19.7%	14.3%	12.8%
ORM-A	10.9%	11.5%	15.1%
Poison	2.8%	2.6%	5.2%
Oxidizers	0.6%	1.1%	1.5%
Explosives	0.0%	0.0%	0.2%
ORM-B	0.0%	0.1%	0.1%
ORM-C	0.0%	0.4%	0.6%
ORM-D	0.0%	0.0%	0.0%

Note: The values have been rounded off to the nearest 0.1.

TABLE 5 AVERAGE AMOUNT OF HAZARDOUS WASTE GENERATED

Reporting Year	Average Amount of Hazardous Waste Per Reporting Generator (Tons)
1982	371
1983	456
1985	344
1986	125
1987	120

Source: Arizona Department of Environmental Quality.

TABLE 6 TOTAL WASTE RECYCLED AS PERCENT OF TOTAL WASTE GENERATED

Reporting Year	Percent
1982	14
1983	44
1985	34
1986	38
1987	62

Source: Arizona Department of Environmental Quality.

regulations that will forbid the disposal of some chemicals that contribute to the waste generated from industrial processes. This action will lead to even further technical advances in the area of hazardous waste minimization, recycling, and the search for alternative raw materials and industrial processes. But again, the amount of hazardous wastes generated that can be avoided is still not precisely known, although some of the firms in Arizona have claimed in their annual reports to the ADEQ to have reduced the volume of wastes significantly. Given these uncertainties, it would be prudent to study the future hazardous waste transportation system under different projection scenarios, i.e., holding the 1985 hazardous waste study shipment amount as the base and projecting it for the year 2000 under different assumptions of waste generation.

First, if the waste generation rate is assumed to equal the rate of growth of the manufacturing industries (i.e., if the new law regarding small-quantity generators and the waste-reduction techniques are not taken into account), the hazardous waste volume projection may be similar to Curve 1 in Figure 6. But the fact is that since the mid-1980s, when stricter laws were passed regarding disposal of hazardous wastes and the costs of treatment, storage, and disposal escalated, minimization of hazardous waste and recycling came into the picture. This process resulted in an overall reduction in hazardous waste volume. In fact, in 1984 and 1986 a reduction of almost 12 percent in generated amounts was observed. This rate of reduction, though, is not expected to be constant and will begin to decrease because of limitations in applications of waste-reduction techniques while greater amounts of wastes will be generated because of industrial growth. This scenario is shown by Curve 2 in Figure 6. Finally, as of 1985, small-quantity generators were mandated by the law to report and dispose of their hazardous waste. This procedure will lead to an increase in volume of hazardous waste. From previous studies, the growth rate for this waste is expected to be about 7 percent annually. Noticeable effects of this new law are expected to be observable from reports of 1987 onwards. However, although small-quantity generators were not reporting disposal activities until recently, shipments may have occurred. The level of such activity versus on-site storage or disposal with regular solid waste is unknown. The effect of this new feature is shown by Curve 3 in Figure 6, which was used in projecting future hazardous waste shipments in this research. The future rate of growth of hazardous waste will be lower than that of manufacturing industries for a few years after 1985. Later, the slope of growth will start getting steeper.

According to the projections of ADES, the Phoenix and Tucson metropolitan areas are expected to remain the centers of population and industrial concentration until the year 2000 and beyond. Therefore, the patterns of hazardous waste shipments will be similar to the ones identified in the 1985 study. Hazardous waste shipments and routings on Arizona's highways were calculated and added to bulk and nonbulk hazardous materials shipments to produce Figure 7. Hazardous waste

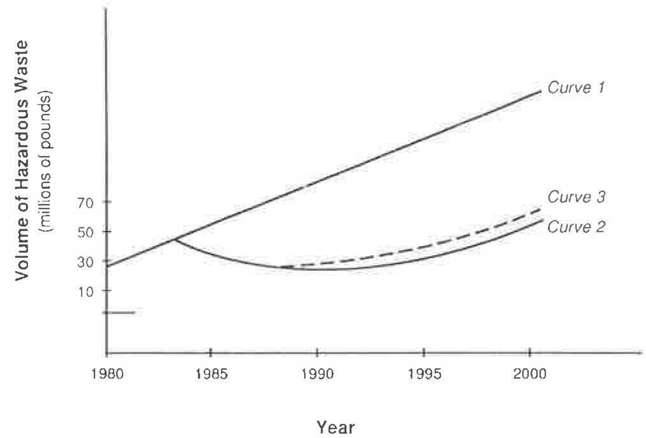

FIGURE 6 Growth in hazardous waste volumes.

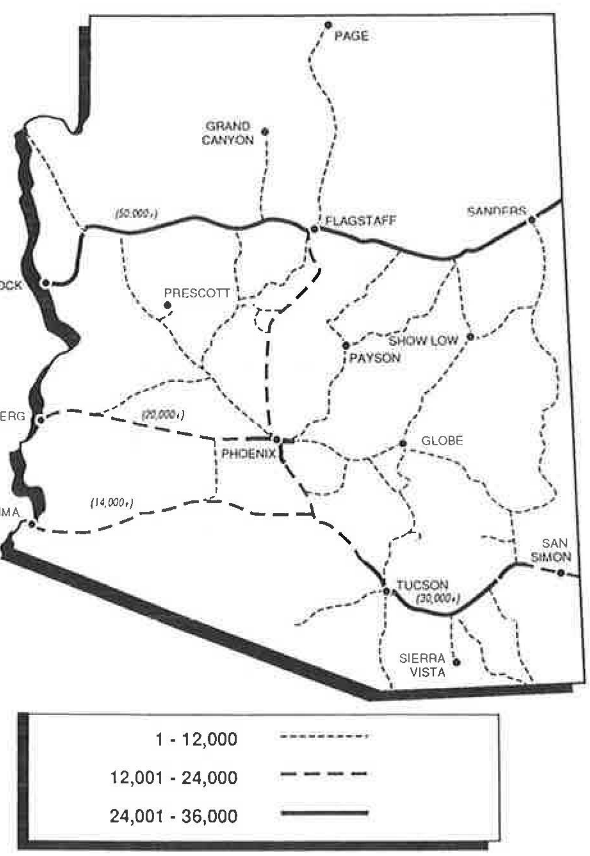

FIGURE 7 Map for hazardous materials and hazardous waste shipments in Arizona for the year 2000.

shipments represent a small fraction of the total hazardous materials and hazardous waste shipments combined.

CONCLUSION

The volume of hazardous materials transported on Arizona highways is expected to almost double by the year 2000. Flammables and combustibles will continue to form a major part of the hazardous materials shipments.

Among internal shipments being handled in Arizona, gasoline transport is expected to increase whereas propane and acids shipments will stay more or less constant. The through-traffic and nonbulk type shipments are expected to increase about 1.8 times. Rapid growth in intraurban shipments is expected to continue in the Phoenix and Tucson areas. The major routes for hazardous materials shipments will be I-40 and I-10 between Tucson and Phoenix and between Tucson and San Simon, respectively. Moderately high levels of hazardous material traffic are expected on I-10 between Phoenix and Ehrenberg and on I-8.

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