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16. Abstract

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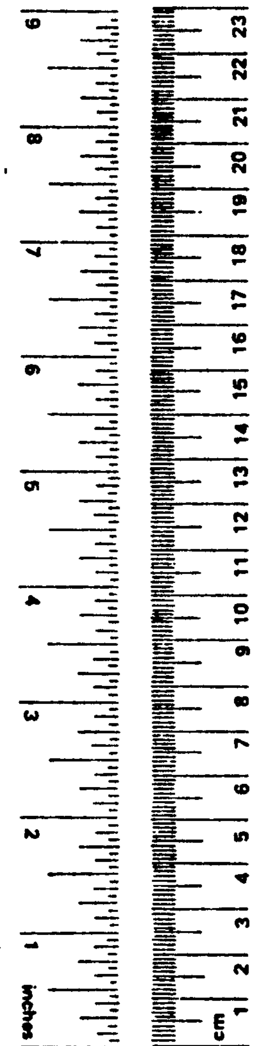
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

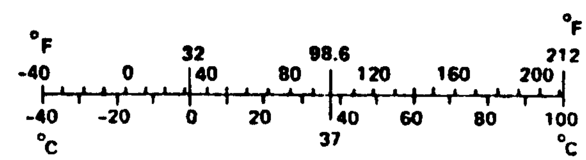
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



IDENTIFICATION OF SPECIAL-USE TRUCK TRAFFIC

by

John M. Mason

Dan R. Middleton

Kay F. Simmons

and

Robert A. Becker

Research Report 420-1
Research Study Number 2-8-84-420
Identification of Special-Use Truck Traffic

Sponsored by

Texas State Department of Highways and Public Transportation
in cooperation with
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October 1985

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas

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This phase of the project was sponsored by the Texas State Department of Highways and Public Transportation. John M. Mason served as the Principal Investigator; Dan Middleton was Principal Staff Engineer. Kay Simmons, a graduate student, modified the computer program developed in Project 299 for oil field activities. Robert Becker, also a graduate student, developed a SAS program for evaluating commodity trends. Mr. Robert Guinn was the Contact Representative for the State Department of Highways and Public Transportation. The following individuals have assisted at various times during the conduct of the study; their continuous guidance and support are greatly appreciated.

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ABSTRACT

The principal objectives of this study were to identify specific special-use commodities, determine vehicular and industry characteristics in the movement of these commodities, determine the areas in the state impacted by this movement, and to develop a procedure for predicting the reduction in pavement life due to special-use truck traffic.

Most of the commodities investigated were determined to need further study. Only poultry and uranium were dropped, while cotton, lignite, and iron ore will be closely scrutinized for possible elimination later.

A computer program was developed as part of Project 299 to analyze the effects of oil field traffic. This program was modified for use in other special-use industries such as timber. It calculates several types of pavement distress and serviceability parameters to evaluate pavement performance under both intended use only traffic and intended plus special-use traffic.

SUMMARY

This study was conducted in response to a need by highway engineers to identify "special-use" industries whose activity centers uniquely impact the highway system in Texas. The primary mode of transport for these facilities was the special-use truck characterized by unique travel patterns, trip lengths, and axle loads.

Three broad "special-use" categories were identified as timber, agriculture, and surface mining. These categories were further refined to include eleven specific commodities: timber, grain, beef cattle, produce, poultry, cotton, sand/gravel, limestone, lignite, uranium, and iron ore. Several characteristics for each commodity were examined. These included industry characteristics, location within the state, commodity flow process, truck characteristics, trips generated, and production trends. This report contains (1) related trip generation information for each identified commodity, (2) an annotated bibliography of pertinent literature and sources, (3) computer program to estimate pavement serviceability, and (4) data on typical truck weights for each commodity.

Information was gathered primarily through telephone interviews or office interviews with industry representatives. Site visits were conducted at selected activity centers so that more detailed information could be obtained. Manual traffic classification counts were conducted only for the timber industry, which included three types of mills. Utilizing the Pavement Damage Program developed under Project 299, it was determined that timber traffic could decrease serviceability such that the roadway will require major rehabilitation 6 months earlier than would be necessary under "intended-use traffic". The analysis procedure can be extended to the other special-use activity centers included within the study. The second phase of the project will involve a comprehensive data collection effort at selected activity centers. The major emphasis will be on trip generation.

Since information regarding special-use truck traffic has not been previously well documented, the findings of this study will undoubtedly assist SDHPT engineers in the areas of planning, research, geometric design, traffic operations, and pavement management.

IMPLEMENTATION STATEMENT

The special-use truck traffic identified in this study is in addition to that traffic already identified in Project 299 concerning oil field activities. Comparison of the relative impact of eleven special-use commodities indicated that the following nine commodities were most significant: timber, grain, beef cattle, produce, cotton, sand/gravel, limestone, lignite, and iron ore.

The information gathered as part of the Phase I activity is sufficient to begin an aggressive data-gathering effort aimed at determining statistically significant trip generation factors. These factors for various sizes of activity centers for each commodity can then be used in the areas of planning, geometric design, traffic operations, and pavement management.

The Pavement Damage Program adapted from Project 299 for use in other special-use activities can be used to assess the reduction in pavement service life due to a specific activity.

DISCLAIMER

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1.0 INTRODUCTION

1.1 OBJECTIVES

The traffic characteristics of "special-use" industries such as timber, agriculture, and surface mining are unique in their distribution of vehicle type, axle configuration, and vehicle weight. Because their travel characteristics are relatively undocumented, trips generated by the special-use activity centers pose problems in the planning, design, and maintenance of the highways that serve their needs. To determine the definitive elements of these isolated traffic demands, the State Department of Highways and Public Transportation (SDHPT) initiated a study which included the following objectives:

* Locate and delineate impacted regions.
* Describe and classify impacted regions.
* Determine traffic characteristics.
* Demonstrate the utility of this information through a case-study example.

1.2 PROCEDURES

Accomplishing the objectives of the study began by identifying special-use industries whose specific commodities and activity centers uniquely impacted the highway system in Texas. The list of specific commodities was refined as industry characteristics were determined; some commodities were found to be more significant than others. Initially, several public agencies were contacted to acquire available information for the selected commodities. In some cases, site visits to one or more activity centers were conducted which included interviews with key industry personnel. Telephone interviews were also used to supplement office interviews to collect site-specific data. Literature, maps, and other pertinent materials were requested by mail. This comprehensive process provided a sufficient data base to preclude future gathering of similar information.

In this initial phase, manual traffic classification counts were conducted only for the timber industry. These counts were made at three types of mills: plywood, particle board, and pulp/paper. Specific traffic data included: traffic volume generated by the mills, baseline traffic existing on the surrounding road network, axle configuration of trucks, general truck size and shape, and commodity being hauled. Manual classification counts were not conducted for other commodities during the first year's effort. Phone interviews, office interviews, and site visits were used to gather information for other commodities. Additional extensive site specific data collection for the nine remaining commodities is planned for future phases of this project.

A case study example illustrates the damage caused by intense timber-cutting activities on a rural surface-treated roadway. The pavement distress computer program developed as part of Project 299 was used to assess this damage. (1)

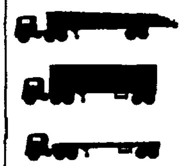
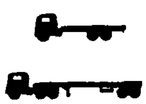
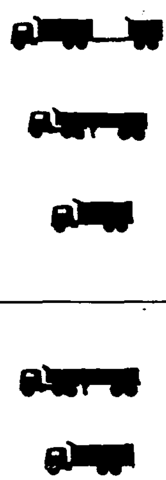
1.3 PREVIOUS RESEARCH

The predecessor to this study was a comprehensive evaluation of the effects of oil field development on roadways in the State of Texas. Therefore, oil field activity was actually the first special-use activity studied, followed by the activities included in the scope of Project 420. Research Reports 299-1 through 299-6 describe the methodology for assessing and predicting pavement damage to the surrounding road network caused by oil field activity. A computer program was developed under Project 299 to model flexible pavement performance under baseline and oil field traffic. (1) Program results estimate various types of pavement distress and provide a basis for selecting appropriate maintenance strategies for each pavement. This Oil Field Pavement Damage Program was adapted as part of Project 420 to predict flexible pavement damage caused by other selected special-use activities.

1.4 SUMMARY

Table 1.4.1 summarizes the information gathered for eleven unique commodities. It should be noted that the information sources were limited. Additional data collection is necessary in all commodity movements to improve the reliability of these data.

Table 1.4.1 Special-Use Commodity Summary

COMMODITY (Activity Center)	COMMON TRUCK SILHOUETTES	MAX. DAILY TRUCK TRIPS (1)	TYPICAL RADIUS OF INFLUENCE (Miles)	TYPICAL WEIGHT RANGE (1000 lb) (2)		PEAK SEASON
				TANDEM AXLE	GROSS VEHICLE	
TIMBER MILLS						
- Paper		580	50	32-38	74-86	Mar.-Nov.
- Plywood		350	50	32-38	74-86	Mar.-Nov.
- Particle Board		280	50	32-38	74-86	Mar.-Nov.
GRAIN - Elevator		300	20	32-40	76-90	May-July
BEEF CATTLE - Feedlot (3)		90	600	32-35	76-82	Yr. Round
PRODUCE - Distributor (3)		600	20	32-36	72-80	Mar.-Apr.
POULTRY - Processing Plant		40 (4)	20	30-34	72-80	Jan.-Oct.
COTTON - Gin (3)		110	15	30-36	72-82	Sep.-Dec.
SAND/GRAVEL - Pit (3)		1,100	60	32-36	70-80	Mar.-Nov.
LIMESTONE - Quarry (3)		2,800	120	32-36	70-80	Mar.-Nov.
LIGNITE - Mine (5)		160	50	32-36	70-80	--
URANIUM - Mine		--	20	32-36	70-80	--
IRON ORE - Pit		--	30	32-36	70-80	--

(1) One-way trips, i.e. one origin, one destination.
(2) Based on experience, conversation, limited weight information, other research projects.
(3) This activity center is large in comparison to other similar activity centers.
(4) Per 8-hour shift. Some plants have 2 shifts per day.
(5) Only a few small operations haul on public roads.

2.0 SPECIAL-USE TRAFFIC

2.1 DEFINITION OF SPECIAL-USE TRAFFIC

The term "special-use" has been coined to give specific designation to truck traffic which is atypical in travel patterns, trip lengths, and axle loads. The travel patterns of these vehicles tend to be cyclical in nature, with the same trip being made in some cases several times in a typical day. Trip lengths are relatively short, usually less than one hundred miles. The origin and destination may remain the same month after month, but usually either the origin or the destination will change after a period of time. Axle loads, although generally not well documented, are in many cases greater than normally expected.

The roads serving the special-use vehicles cover practically the entire spectrum. One particularly noteworthy roadway type which is common is the two-lane rural road. These roadways are usually paved, surface-treated roads intended for low traffic volumes with a small percentage of large trucks. Finally, special-use truck traffic in many cases experiences seasonal variations due to rainfall or the harvest season, as in the agricultural commodities.

2.2 IDENTIFICATION OF SPECIAL-USE INDUSTRIES

The special-users identified in this study fall into three categories: timber, agriculture, and surface mining. Table 2.2.1 is a list of specific commodities evaluated in this study, including some which were investigated previously or eliminated in this initial phase. The impact of oil field development was evaluated in Project 299. A problem statement concerning hazardous materials movement has been submitted by other researchers; it is therefore omitted from this study. In addition, some commodities within the three selected industries were omitted because the total quantity being hauled by truck was relatively small.

TABLE 2.2.1 Special-Use Commodities

TIMBER	AGRICULTURE	SURFACE MINING	OTHERS
Timber	Grain Beef Cattle Produce Poultry Cotton *Other Livestock Peaches	Sand/Gravel Crushed Stone Lignite Uranium Iron Ore	*PowerPlant Construction *Hazardous Materials *Petro-Chemical Products *Oil Exploration

* Indicate other special-use activities not evaluated in this study.

3.0 CHARACTERISTICS OF INDUSTRIES AND INDUSTRY TRAFFIC

A description of the industry characteristics and the traffic generated by these industries is given below. For each of the eleven commodities, the following are described: industry characteristics, location within the state, commodity flow process, truck characteristics, number of vehicular trips generated by specific activity centers, and the annual amount of each commodity being transported.

3.1 TIMBER

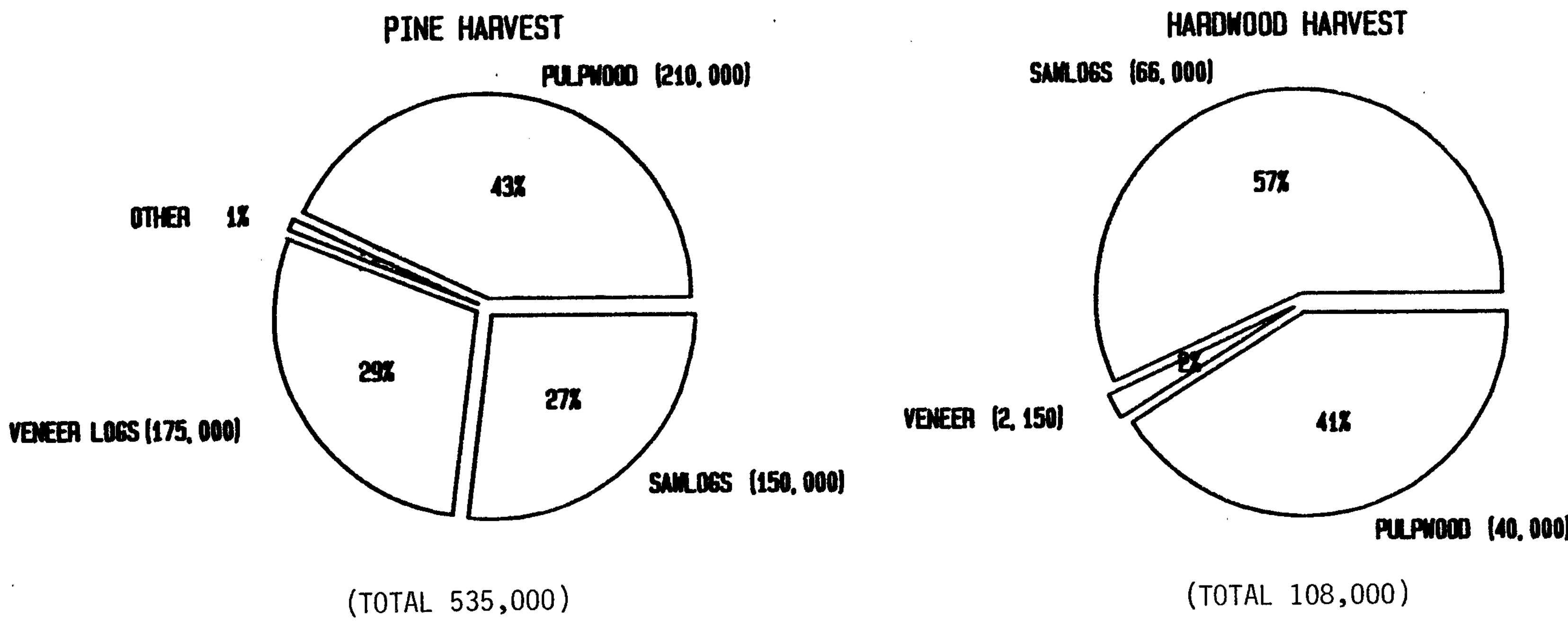
3.1.1 Industry Characteristics. Timber truck traffic begins when a contractor moves into an area and begins cutting selected trees. The trees may be cut into 8-foot lengths if they are to be used for paper or plywood; otherwise, the trees are cut in lengths of 40 to 60 feet. The trees are then loaded onto a truck and are transported to the mill on public roads. The mills process the logs from the forests and use timber by-products such as bark, sawdust, and chips for fuel. The finished products are loaded onto a truck or rail car and shipped to a distributor or a retailer. The distance between the cutting site and the mill is usually 60 miles. If the economics are favorable, a company will have a cutting site over 100 miles from the mill.

Timber truck movement is affected by four factors: weather, economy, railroad, and timber's growing cycle. The rainfall in an area is the major influence on timber truck traffic. When the ground is wet, the trucks and cutting machinery cannot operate in the forest. The harvesting process stops until the ground is dry enough to continue work. Timber truck activity is high in the months preceding the rainy season since the mills are laying in supplies of raw material, thus enabling the mills to maintain a constant level of production during the rainy months. Another important influence on the timber truck movement in an area is the economic situation. When the construction industry is depressed, the demand for lumber is low, and therefore, the timber industry will slow its harvesting efforts.

The use of railroads by the majority of the timber mills (plywood and particle board) is insignificant. On the other hand, paper mills depend heavily on the rail system. The mills receive some of their raw wood material in the form of chips from other mills, and they also transport some of their bulky paper items such as the paper used by newspapers and magazines by rail.

Another characteristic of the timber industry involves the cycle of tree growth. Once an area has been clear cut (all trees have been removed), it takes 15 to 35 years before the stand of trees is ready for another harvest. If selective cutting is used (only certain trees in the area are removed), cutting activity may occur every 5 years.

One timber truck load is equivalent to approximately 10 cords of wood or 3,500 to 4,500 board feet. Over 650,000 trucks per year haul wood to the various mills; approximately 165,000 trucks leave the mills with finished products. Each type of mill generates its own particular mix of traffic. Figure 3.1.1 shows the proportioning of the end products of the 1981 pine



*Numbers in parenthesis indicate annual number of truck loads.

Figure 3.1.1 Usage of the 1981 Pine and Hardwood Harvest

and hardwood harvest and the corresponding volume of trucks needed to transport these products. (2) Total pine movement is approximately five times the hardwood movement. The respective percentages of end products are also quite different between softwood and hardwood, with the exception of pulpwood which was approximately 40% of the total for both softwood and hardwood.

3.1.2 Flow Chart/Location Map. The flow chart in Figure 3.1.2 illustrates the processing of wood from cutting site to consumer. The region which is suitable for timber operation is a 40-county contiguous area in East Texas shown in Figure 3.1.3. (3) The locations of timber mills are shown by Figure 3.1.4. (4)

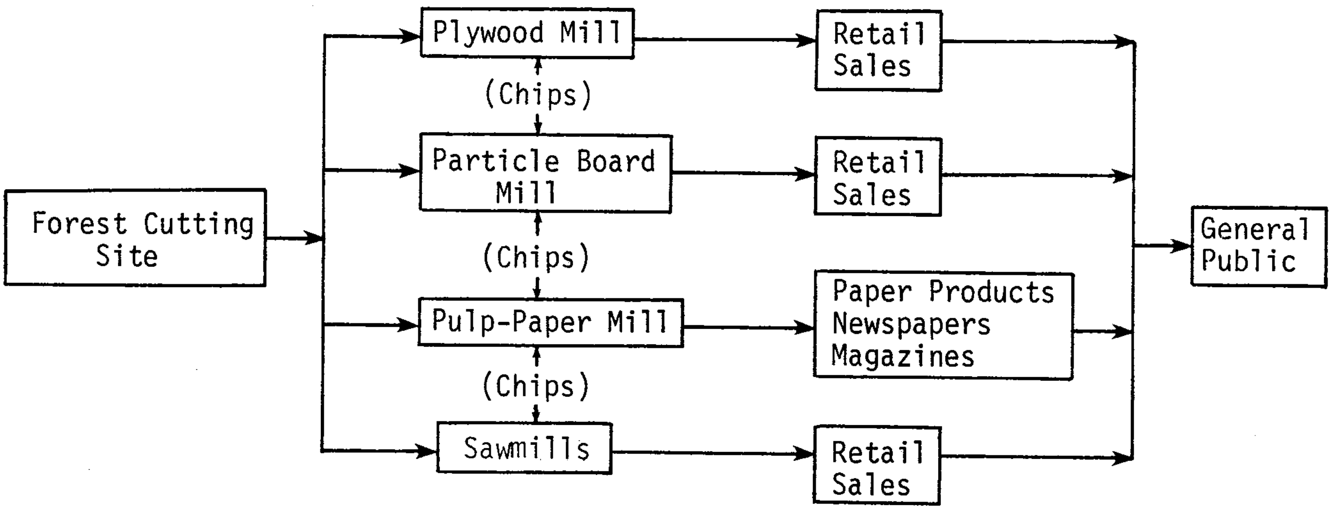


Figure 3.1.2. Timber Flow Chart

3.1.3 Truck Characteristics. Timber is hauled from the forests almost exclusively on 3-S2 vehicles. Many of the trailers have a single tubular frame which is hinged at its midpoint such that the trailer tandem can be easily pulled onto the tractor frame. This trailer is called a "fold-up" log trailer. With the trailer folded and pulled onto the tractor, the vehicle returns to the woods as a single unit truck. Trailer units which haul 8-foot lengths of logs crosswise are more rigid and heavier than the fold-up trailers. Finished products are hauled from a mill using either the 3-S2 or possibly the 2-S1-2 with flat-bed trailers. Wood chips are brought into the mills in 3-S2 vehicles with trailers which are enclosed except for the top and half rear door. Few single unit trucks are used to haul raw timber and wood by-products to and from the mill. The very smallest timber cutting contractors use single-unit "coke" trucks to haul the wood which is usually loaded by hand.

3.1.4 Vehicular Trips Generated. The movement of timber was more thoroughly examined than were the other commodities. Two activity centers--cutting sites and mills--were evaluated versus one activity center for the others.

A timber cutting site may be on public or private land, but in all cases, a private contractor is hired to cut the timber. Passenger car trips are usually slightly higher for public lands because the operations are additionally supervised by a public agency. Truck traffic is greatest on

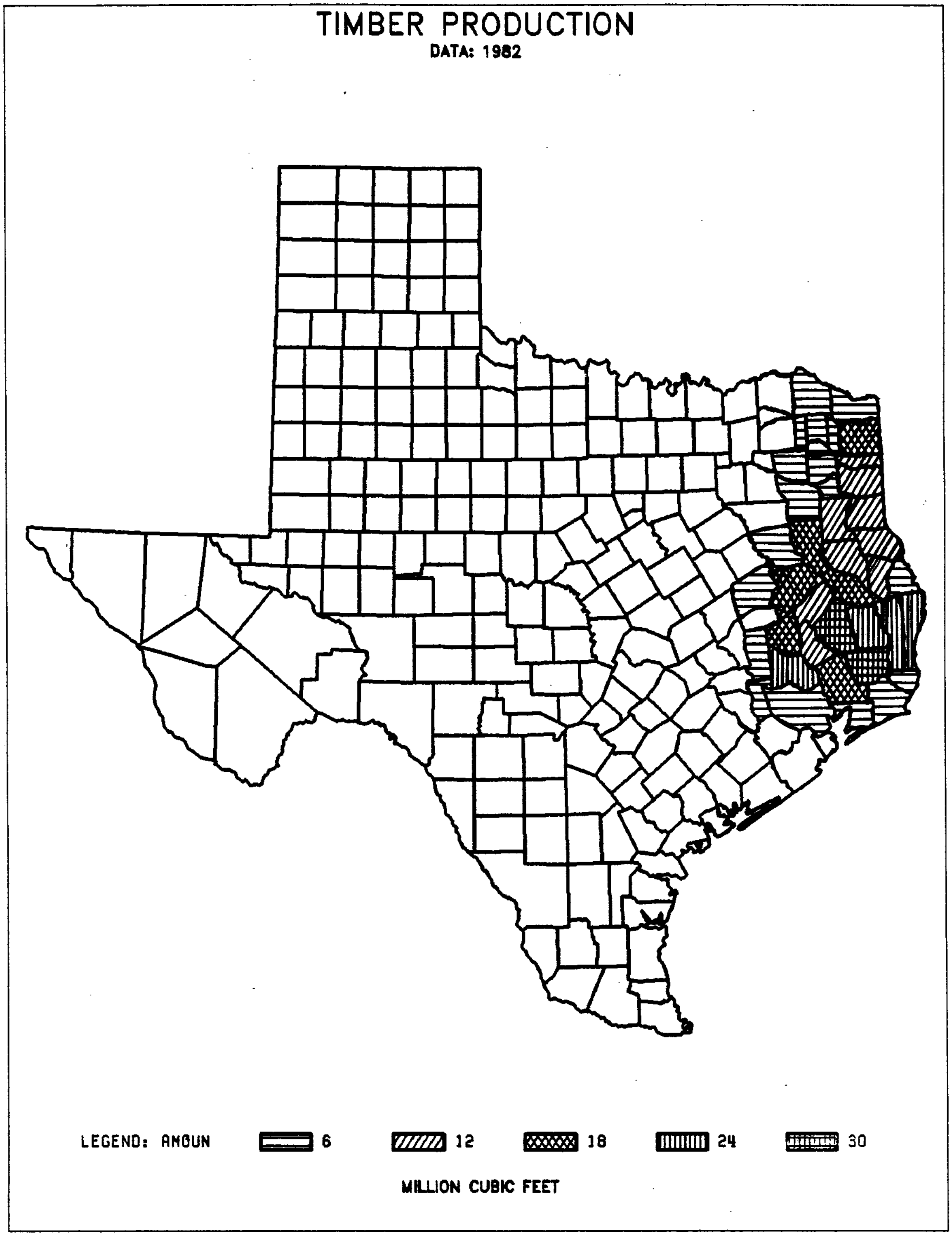


Figure 3.1.3 Location and Intensity of Timber Operations

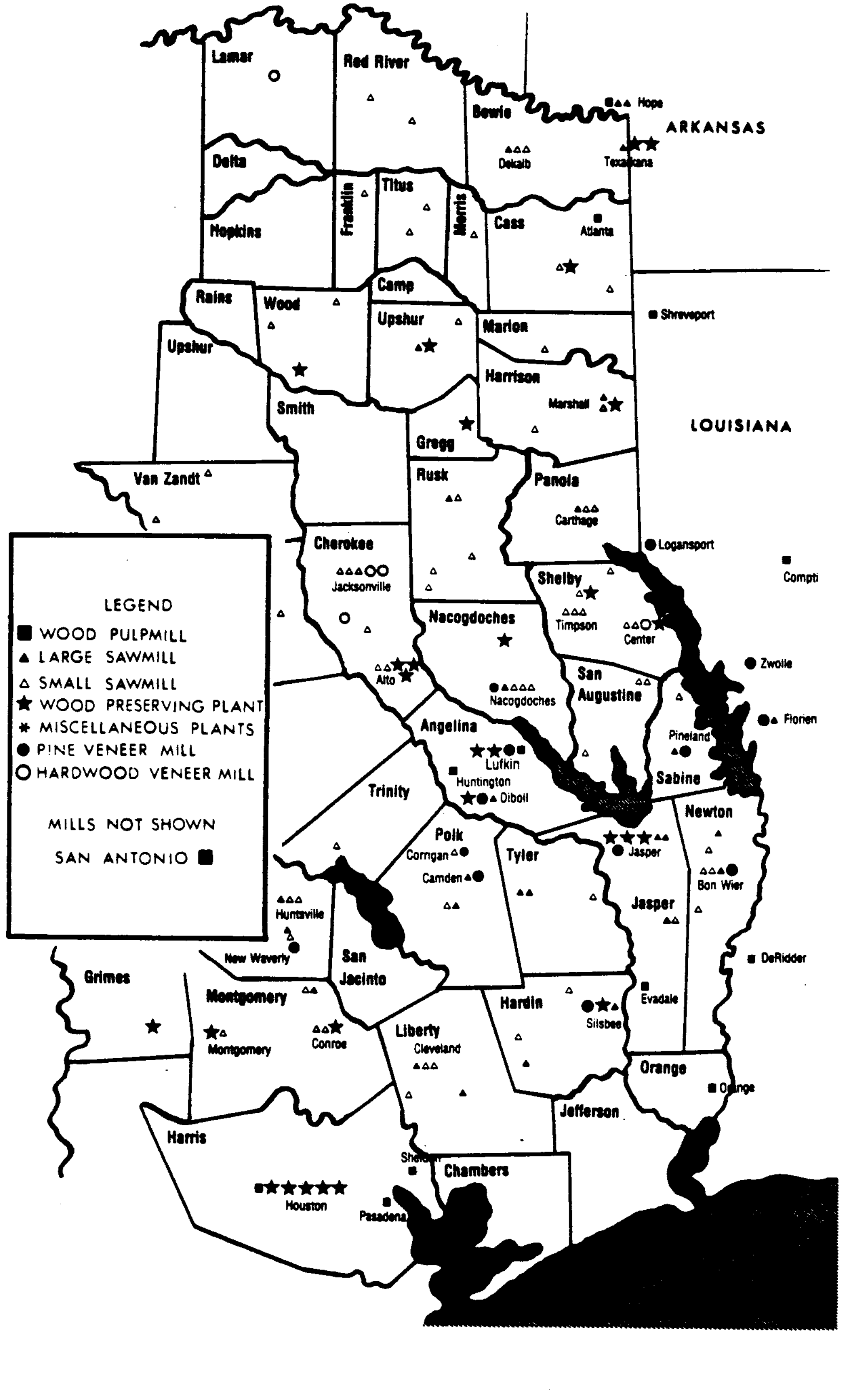


Figure 3.1.4 Location of Timber Mills

company-owned lands where commercial harvesting operations are more intensive. Specific information relative to cutting on private land was difficult to obtain. According to the Texas Forest Service, public lands with forests represent approximately 7 percent of the total forest lands, company/industry lands are 34 percent of the total forest lands, and private land owners own the remaining 59 percent.

For practical purposes, trip generation at the cutting site is on a per-acre basis. Too many variables exist to accurately evaluate trips on a time basis. However, given that the weather does not interfere with cutting and machinery breakdowns do not occur, Table 3.1.1 lists approximate monthly averages to be expected for a small, average, and large contractor:

Table 3.1.1 Timber Trip Generation Per Unit Time

Contractor Size	Number of acres	Number of 3-S2 loads* (month)	(day)**
Small (clear) (selective)	20 45-50	45	3
Average (clear) (selective)	50 100	100	5
Large (clear) (selective)	150 300	300	15

* Using 2.5 truck loads per acre clear cut and 1 truck load per acre selective cut.

** Using 5-day work week.

Data collection for timber began with agency contacts: Texas Forest Service, U.S. Forest Service, American Pulpwood Association, National Forest Products Association, and the Forestry Department of Texas A&M University. Site visits were made to four cutting sites representing small, average, and large contractors plus an atypical, very intensive operation by the U.S. Forest Service in which a large helicopter was used to move logs from the cutting site to the loading site. The latter was a unique special attempt to stop the spread of the pine bark beetle.

This helicopter operation generated an average of 30 to 35 3-S2 truck loads per day with a maximum of 50 per day. The U.S. Forest Service generated 40 additional passenger-vehicle trips per day. Each 3-S2 truck carried 25 to 40 stems (logs) which totaled 5000 to 7000 board feet per load. Using a conversion of 1000 board feet = 12,200 pounds, these trucks carried a payload of 61,000 to 85,000 pounds. A total of 15 million board feet of timber has been hauled from this site in a 5-month period.

The more typical large timber contract job generates twenty 3-S2 truck loads per day, while an average-size operation might generate five 3-S2 truck loads per day. A small operator, on the other hand, would generate only two 3-S2 loads per day.

The other activity center besides the timber cutting site was the mill. An average size paper mill has 150 to 230 trucks entering per day. This value is extremely dependent upon the usage of railroads by the mill. A plywood mill will have between 60 and 65 truck loads enter per day and 15 truck loads exit per day. A particle board mill of average size also receives about 60 truck loads per day. A typical large sawmill requires 65 to 70 incoming 3-S2 loads of logs a day, while an average sawmill needs 15 to 30.

3.1.5 Traffic Classification Counts. Manual traffic counts were performed for a 12-hour period at three types of mills: pulp/paper, plywood, and particle board. Three criteria helped identify the specific mills to be counted: (1) ease of counting the traffic generated (T-intersection), (2) central location near Lufkin, and (3) mills located near Highway 59.

The count took place on a Friday in January from 6:30 a.m. to 6:30 p.m. in weather which was cold (30-40° F) and clear to partly cloudy all day. It had rained on Monday and Tuesday of the same week, but Wednesday and Thursday were dry and cold.

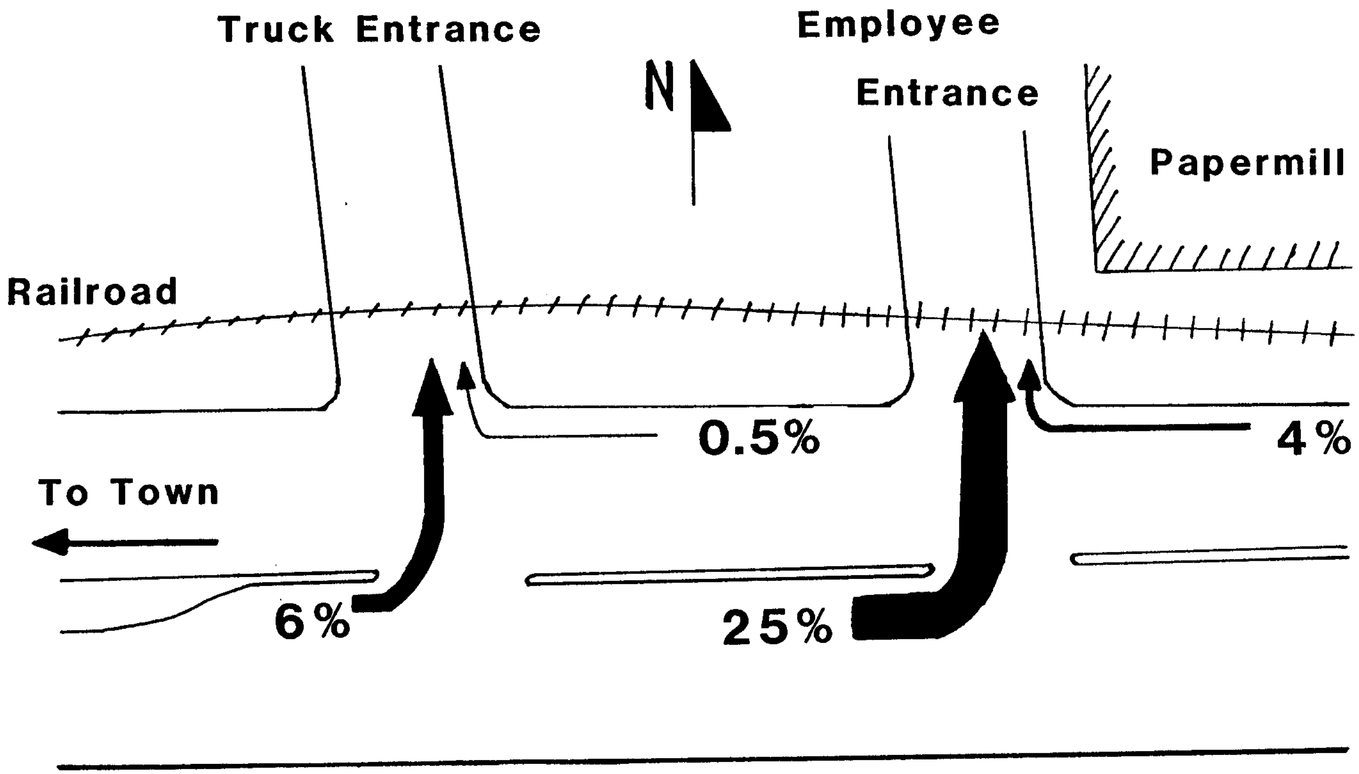
3.1.5.1 Pulp/Paper Mill. The pulp/paper mill was one of the largest in Texas, served by both a railroad and a State Highway. The average daily traffic on the Highway was 8,800 vehicles per day. There was only one arriving and one departing train during the count day. To the west of the paper mill was a small city, and to the east was a national forest. Almost all the traffic generated by the mill was oriented toward the west.

Figures 3.1.5 through 3.1.11 describe the truck traffic and total traffic generated by the pulp/paper mill. Figure 3.1.5 shows access points for the means of entering the mill by employees and others. Figure 3.1.6 indicates the number of cars and trucks using the truck entrance by time of day. Figure 3.1.7 indicates the total number of trucks and cars by time of day using the State Highway. The total number of cars and trucks using the employee entrance is shown in Figure 3.1.8. Figures 3.1.9 through 3.1.11 show the traffic breakdown by AASHTO classification on the State highway, the truck entrance, and the employee entrance.

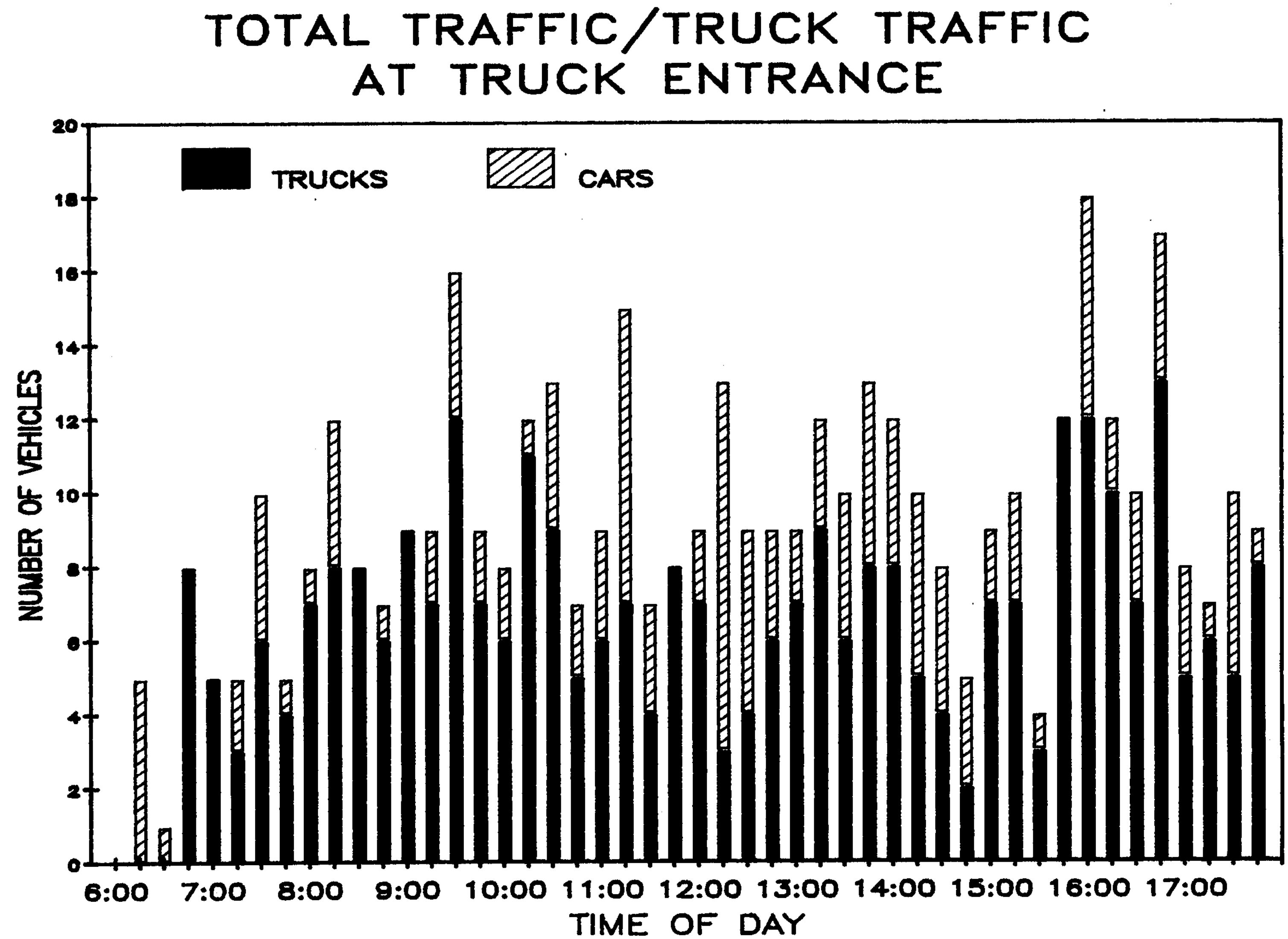
3.1.5.2 Plywood Mill. The capacity of the chosen mill ranks it as an average size plywood mill. Truck traffic for this type of mill should be 60 to 65 truck loads per day in, and 15 truck loads per day out. This mill was located west of a city and between two National Forests, but had no rail service. The state highway serving the mill had an ADT of 7,700. The plywood mill had three entrances: one for the log trucks to enter and be weighed, another for the employees, and a third for trucks hauling finished products.

The plywood mill had 140 3-S2 trucks enter the scale entrance during the 12-hour count period. Nine of these trucks were hauling finished products, 23 were empty going into the mill, while 108 3-S2's were entering the scale entrance carrying logs. The plywood mill accounted for 5 percent of the total traffic and 13.5 percent of the total truck traffic on the State Highway. There was over 12 percent truck traffic on the highway.

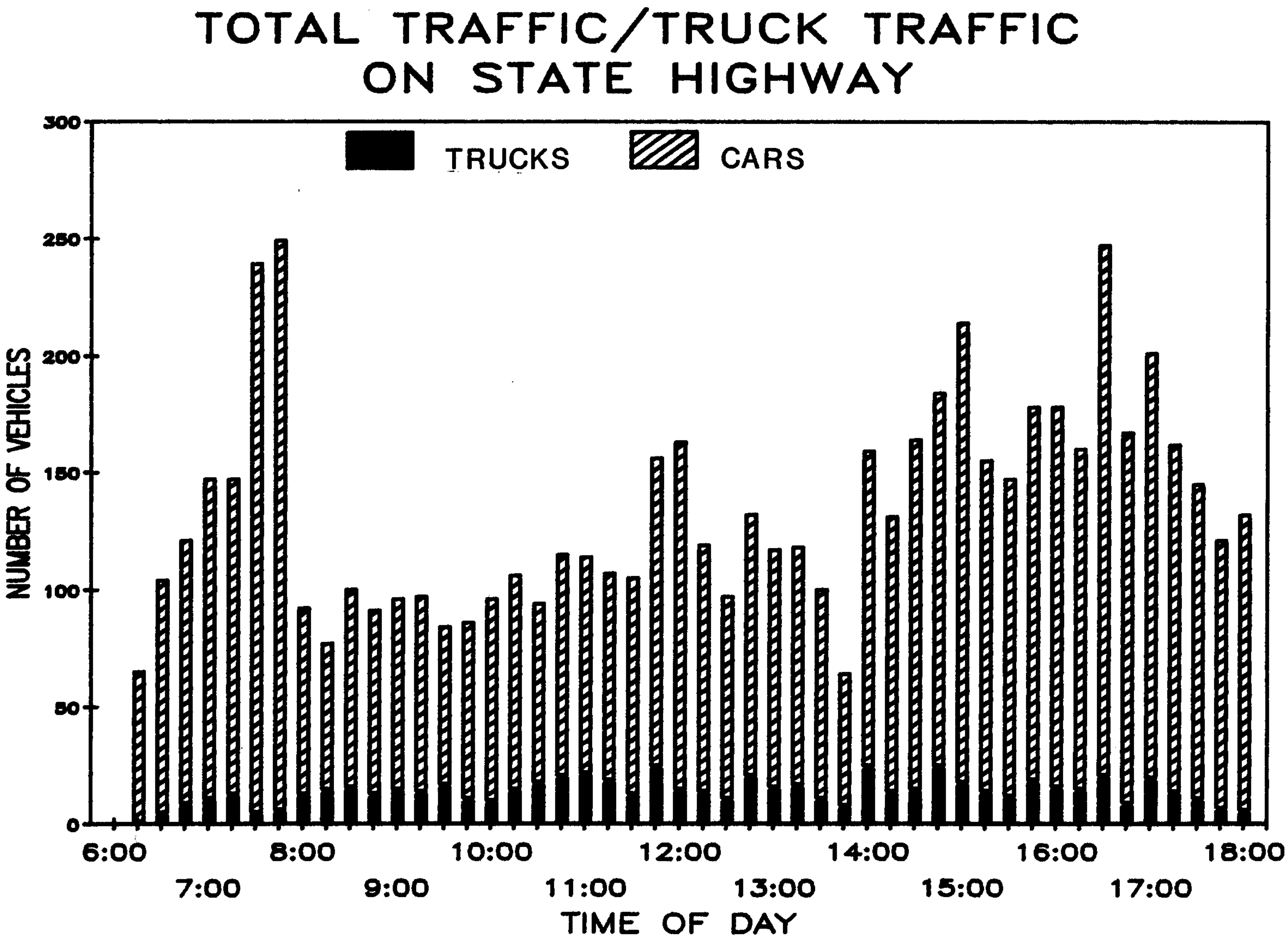
The 108 3-S2 log trucks entering the mill in a days time is somewhat greater than would be expected for an average size mill such as this one.



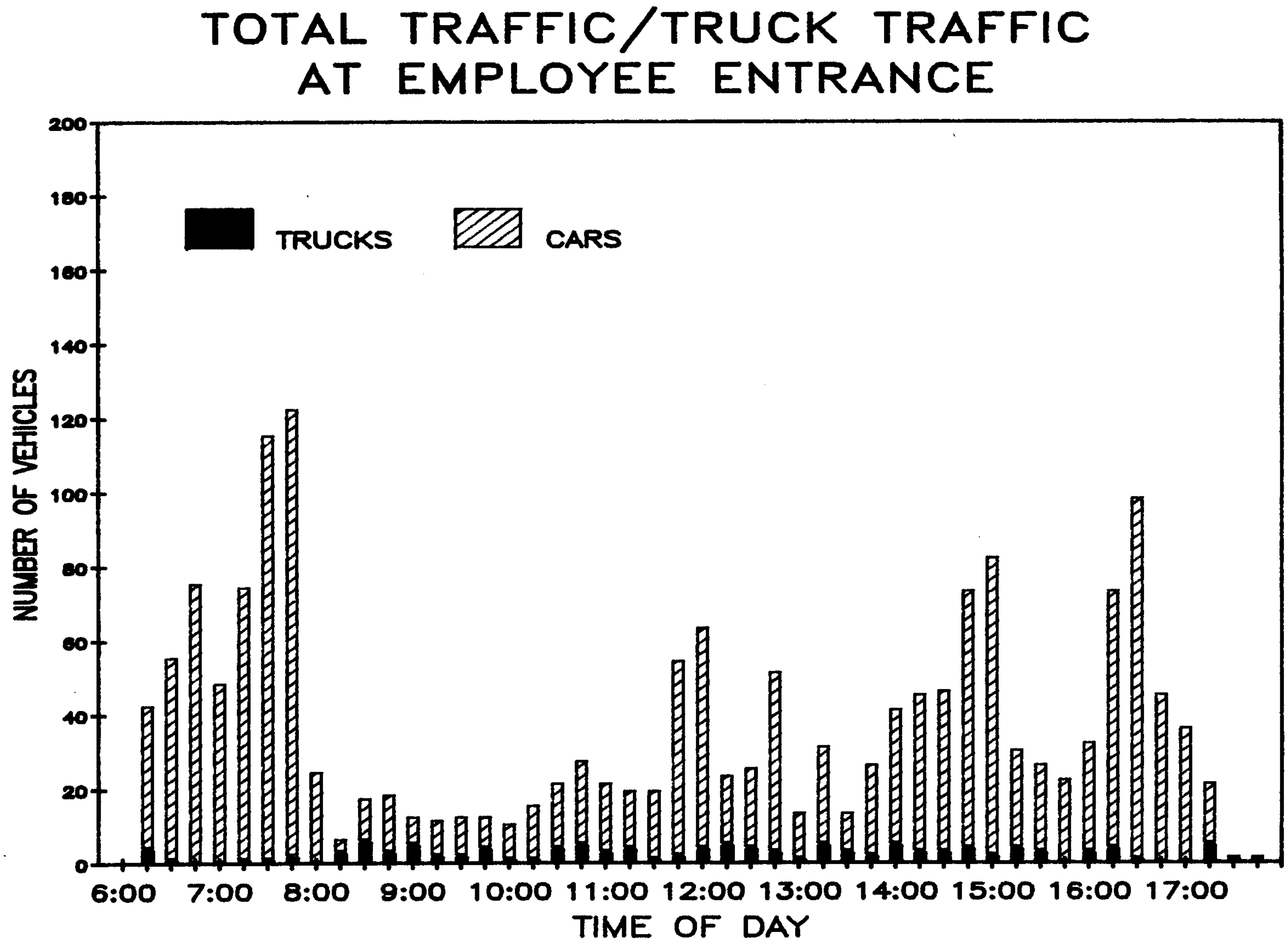
3.1.5 Percent of Total Traffic on State Highway
Going into Papermill



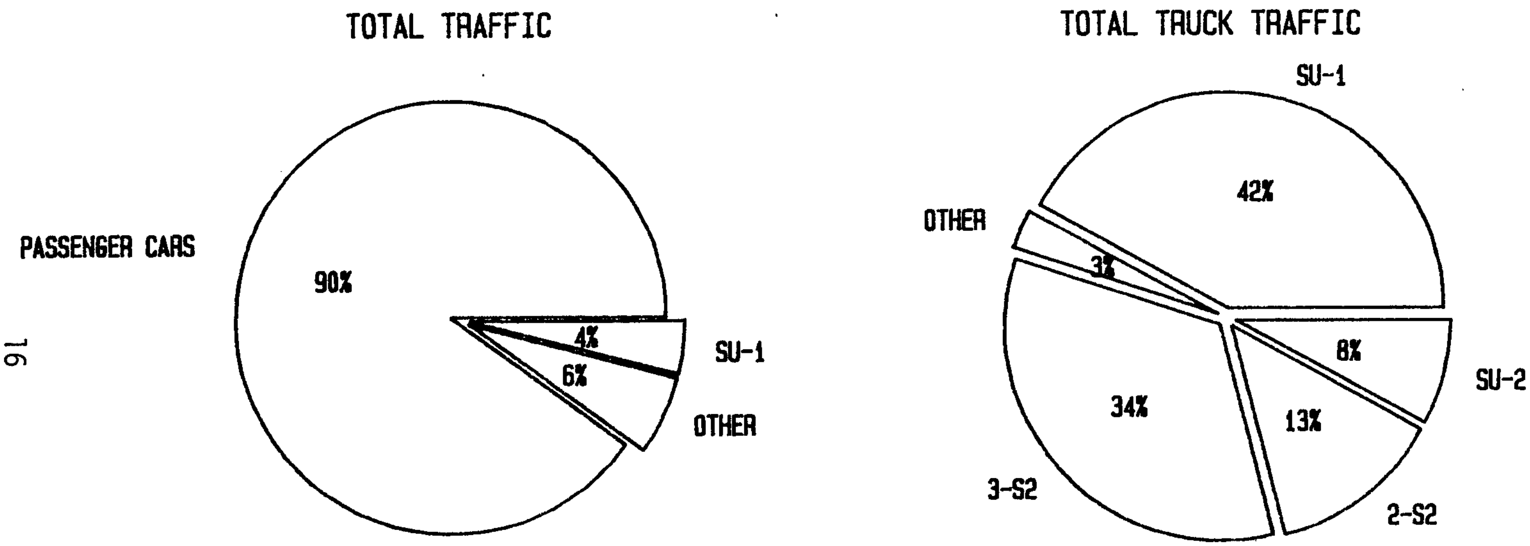
3.1.6 Total Traffic/Total Truck Traffic Using Truck Entrance



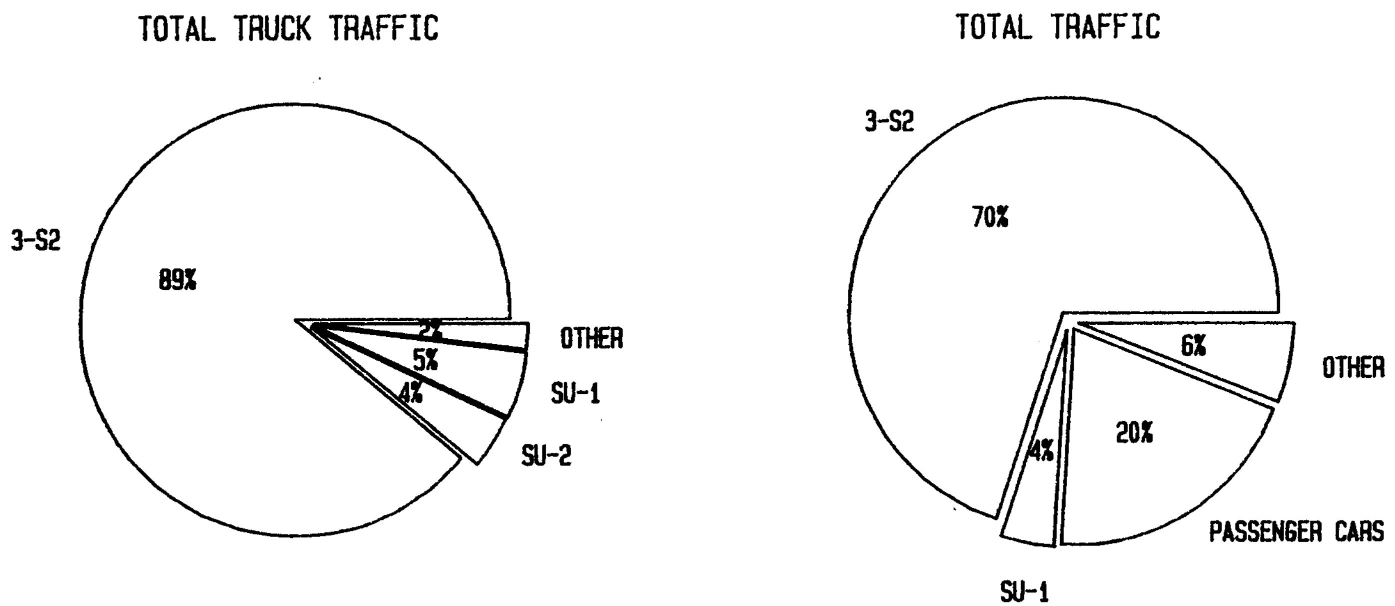
3.1.7 Total Traffic/Total Truck Traffic on State Highway



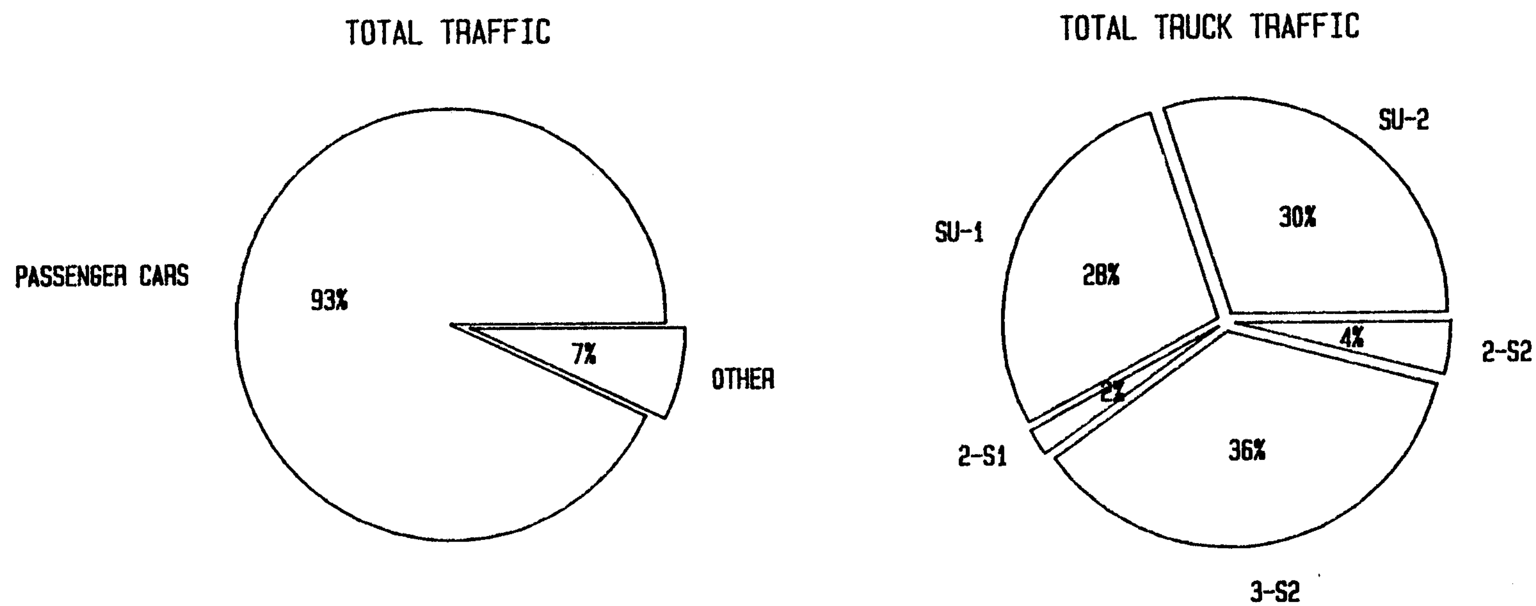
3.1.8 Total Traffic/Total Truck Traffic Using Employee Entrance



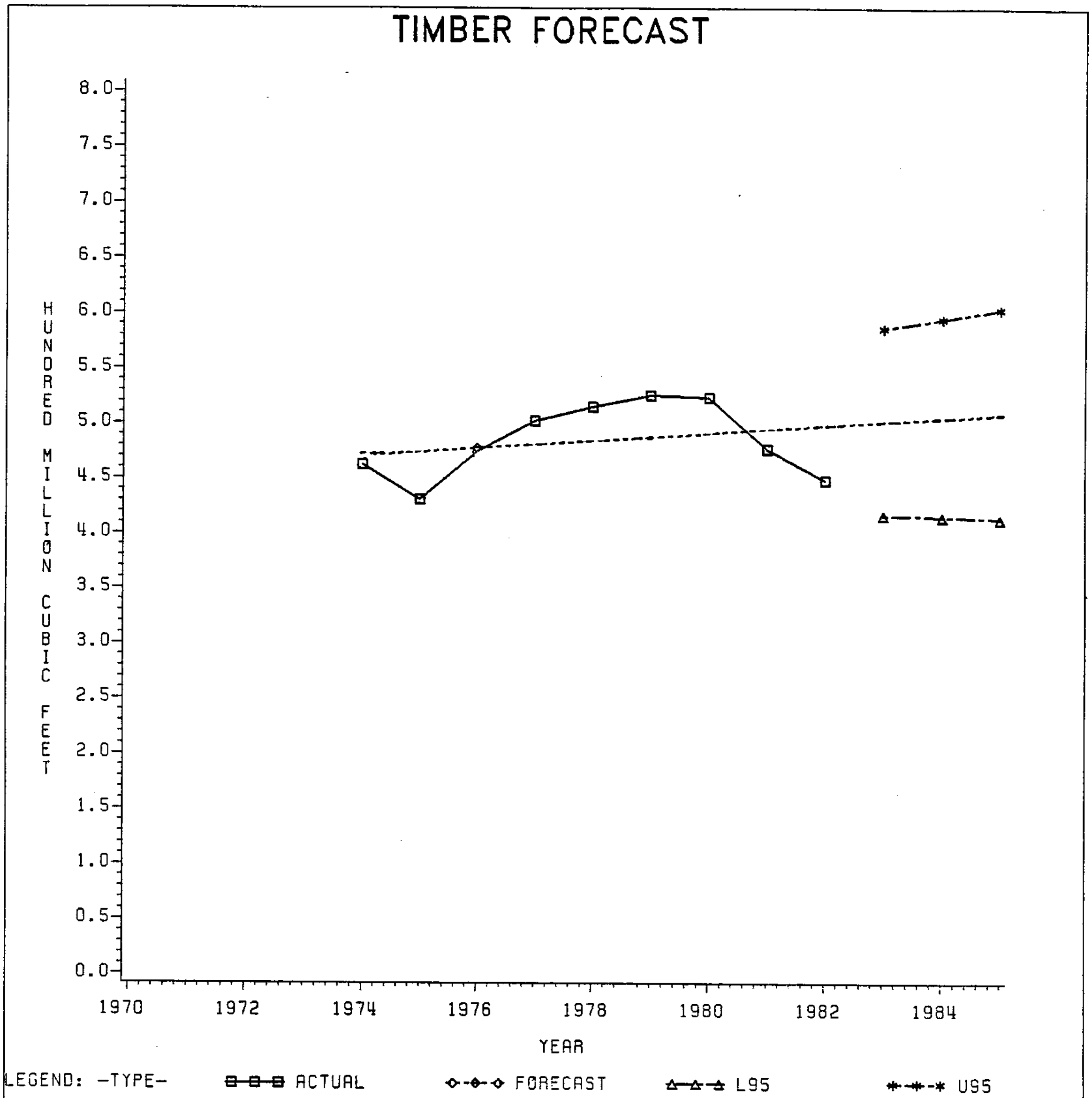
3.1.9 Pie Charts of Total Traffic/Total Truck Traffic on Highway



3.1.10 Pie Charts of Total Traffic/Total Truck Traffic at Truck Entrance



3.1.11 Pie Charts of Total Traffic/Total Truck
Traffic at Employee Entrance



3.1.12 Trend and Forecast in Harvested Timber

An average mill typically needs 60 to 65 truck loads per day while a large mill needs 135 to 150 loads per day. One reason for the larger than expected number of loads might be the previous rains which could have depleted the mill's stockpile of raw wood. A higher rate of cutting and hauling would then have been necessary to replenish this stockpile.

3.1.5.3 **Particle Board Mill.** The capacity of this particle board mill, as extracted from the Directory of Forest Product Industry, ranks the mill as an "average" size. This means that it requires about 60 truck loads per day. The mill entrance was located on a short road off U.S. 59 (12,400 ADT). There were a few single-family dwellings and a car repair shop on the short road generating some passenger car and single-unit truck traffic.

There were 88 loaded 3-S2 log trucks which entered the particle board plant during the 12-hour count period and 20 3-S2 flatbeds which left loaded with finished products or wood by-products. Most of these were loaded with particle board but a few were loaded with posts or wood chips. The chips are used for fuel at other timber mills.

The percentage of traffic on U.S. 59 generated by this mill was 6.7 percent of the total truck traffic and 4.6 percent of the total traffic. Over 21 percent of the traffic stream on U.S. 59 was trucks--highest of the three sites.

A total of 88 trucks entered this mill compared to 60 truck loads per day for an average mill. A possible explanation for this difference was the rain which had come a few days earlier. The ratio of four trucks entering with raw material to one truck leaving with finished products agrees with the data collected elsewhere.

3.1.6. **Trends.** The trend in the amount of total timber harvested statewide from 1974 to 1982 is shown by Figure 3.1.12. In this same figure, a simple linear regression yields a gradual increase in timber harvested through 1982. Projection through 1985 with 95% confidence levels is shown. The plot of actual timber harvested shows a significant drop in production from 1980 through 1982, primarily due to a reduction in housing starts during the 1981-82 period.

Establishing trends for the location of specific cutting sites is much more difficult than establishing trends in total timber harvested. Since the vast majority of timber cutting activities are on private land, there is no public agency involved to monitor or control the activity. A contract period of 18 to 24 months is allowed for the timber-cutting contractors to accomplish this task which may only take two months. The exact timing of these two months within the total allowable contract period depends upon the weather, the economy, and the contractor's other commitments. Therefore, it is difficult to establish trends without at least a general knowledge of where cutting has occurred over the past several months. Two methods which might be considered to determine trends are aerial photography and remote sensing (satellite imagery).

3.2 GRAIN

3.2.1 Industry Characteristics. Grain is usually grown near its point of need and in locations where soil and temperature conditions are optimum. In Texas, the predominant areas of grain production are the high plains and Gulf Coast areas. These areas and others are defined by Figure 3.2.1. (5) The high plains grain is used heavily in cattle feedlot operations, whereas that grown in the Gulf Coast area is transported almost exclusively to Texas Gulf ports. Grain sorghum is shipped from the various regions by rail and truck. Table 3.2.1 lists the distribution of grain from each region to three selected destinations. (6)

In many cases the grain is first taken to an elevator where it is stored before it is shipped to a feedlot or a port. The grain may be shifted from one elevator to another, depending upon supply and demand. The length of time the grain remains in the elevator is determined by economics, number of ships in the port, and the needs of the feedlots. The distance from the field to the first elevator is approximately 20 miles. The travel distance from elevators to feedlots and feed mills are also short, usually not over 50 miles. The distance that grain must travel from its first storage to the port is much greater. This long shipping distance (over 200 to 300 miles) is usually done by rail.

Grain movement by truck obviously is the heaviest during the harvest season, May to July in Texas. Movement of grain can also be significant during other portions of the year, since it is sometimes moved to other elevators. The first elevator is used for storage until the grain is needed elsewhere. When there is a need for grain, such as when ships come into the Gulf ports ready to load, truck and rail movement of grain are greater. Generally the grain is taken from the smaller storage elevators by truck and from the larger elevators by rail. As much as 45 to 100 percent of this movement may be by rail, depending on the circumstances. For other grain movement, such as from one elevator to another or from elevator to feedlot, a smaller percentage is moved by rail, typically 2 to 30 percent.

3.2.2 Flow Chart/Location Map. A flow chart which shows the processing of grain from the producers to various destinations is shown below in Figure 3.2.2. Various grains are grown in several regions of the state as indicated by Figure 3.2.3. (7) Predominant areas are the Northern and Southern High Plains, and the Gulf Coast regions as defined by Figure 3.2.1.

3.2.3 Truck Characteristics. The type of truck predominantly used to move the harvested grain from the field to the first elevator is a single unit, 3-axle truck (SU-2). A 3-S2 truck is used to move the grain collected at the first elevator to feedlots, feed mills, or other grain elevators. Each trailer has a removable top with built-up sides to hold the grain. Almost all grain is dumped through openings in the bottom of the trailer.

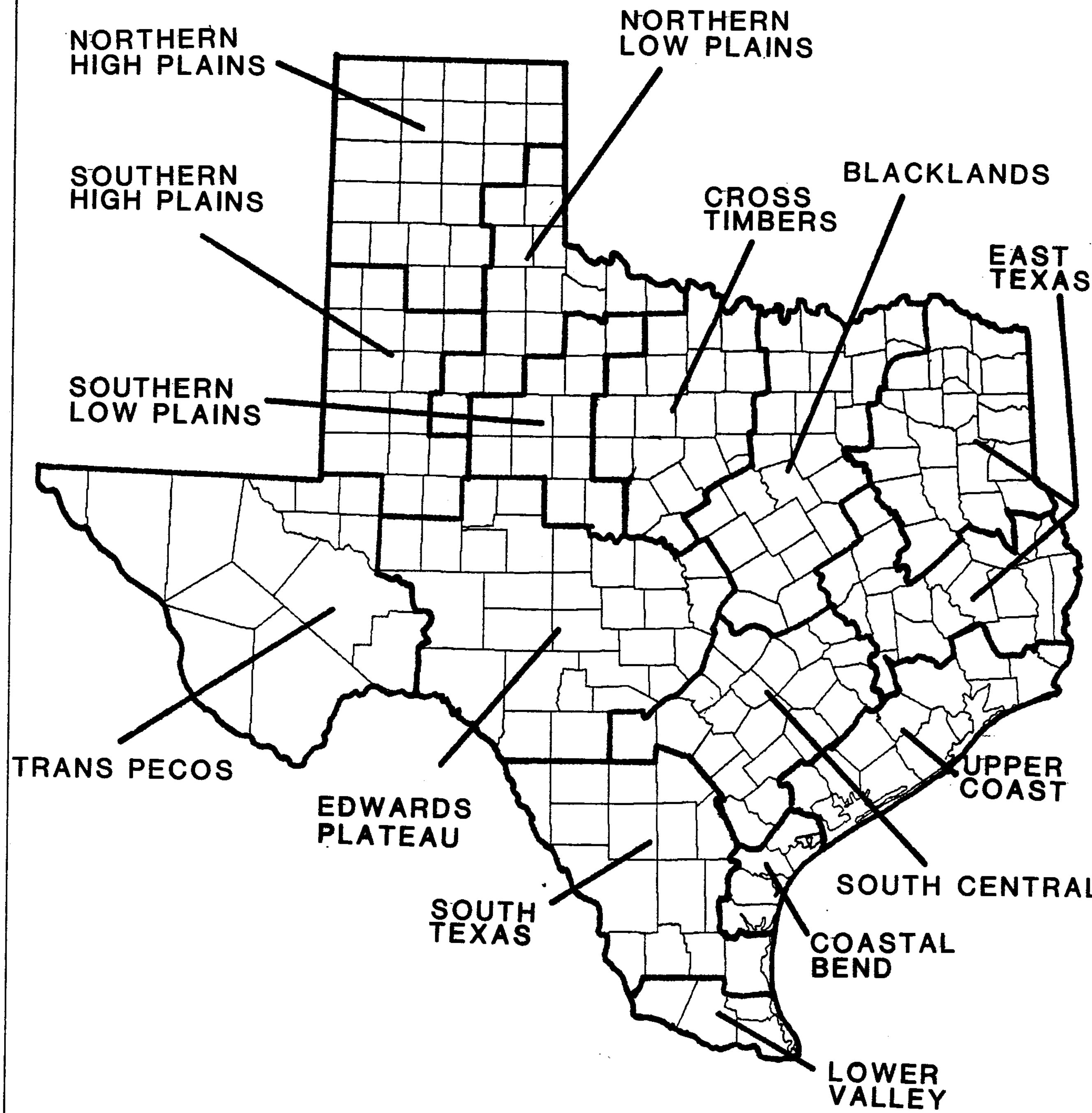


Figure 3.2.1 Indentification of Texas Agricultural Regions

Table 3.2.1
Estimated Modal Split of Texas Grain Sorghum from Texas Grain Elevators to Various Destinations

	------DESTINATIONS------					
	HOUSTON-BEAUMONT-GALVESTON AREA PORTS		TEXAS FEEDLOTS		TEXAS GRAIN ELEVATORS	
SHIPPING REGION*	% TRUCK	% RAIL	% TRUCK	% RAIL	% TRUCK	% RAIL
NORTHERN HIGH PLAINS	1.5	98.5	95.6	4.4	80.3	19.7
SOUTHERN HIGH PLAINS	0.0	100.0	98.5	1.5	87.8	12.2
ROLLING PLAINS	15.1	84.9	100.0	0.0	24.7	75.3
EAST TEXAS	13.4	86.6	90.3	9.7	50.9	49.1
GULF COAST	92.9	7.1	96.9	3.1	0.0	0.0
RIO GRANDE PLAINS	0.0	0.0	100.0	0.0	0.0	0.0
PECOS PLATEAU	71.4	28.6	100.0	0.0	100.0	0.0

*See Figure 3.2.1

Source: "Texas Feedgrain Flows and Transportation Modes, 1974," The Texas Agricultural Experiment Station, Texas A&M University.

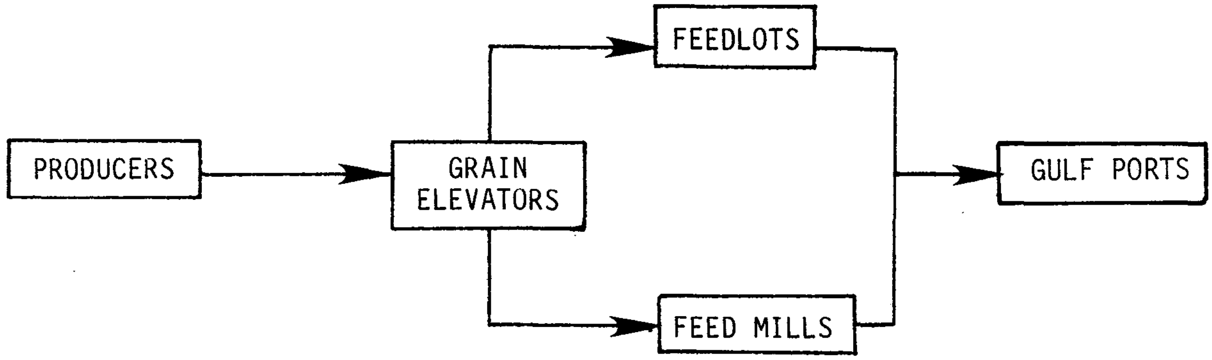


Figure 3.2.2 Grain Flow Chart

3.2.4 **Vehicular Trips Generated.** The activity center chosen for grain was the grain elevator which, for those operations studied, was used for short-term storage. Much of this grain was used at feed mills located very close to the elevator. The remainder of the grain was transported to other elevators or to shipping ports. Three elevators were visited in East Texas, yielding the following information:

Elevator	Capacity (1,000 bushels)	Truck loads (SU) received per day
A	359	80
B	415	70
C	2,000	100

Elevator "A" receives its grain from area farms within 20 miles and sends 85 percent of this grain to a nearby feed mill. This feed mill needs one 3-S2 load of grain every 1 to 3 days. Little or no rail usage occurs with elevator "A".

Elevator "B" ships 50 percent of its corn by rail, mostly to feed mills. Most of the wheat and milo go to Gulf ports. All of the grains come from area farms within 20 miles and are shipped mostly by rail. Trucks bringing grain are predominantly SU-2, with some SU-1's carrying 25,000 to 36,000 pounds of grain. The peak intake is 2 million pounds per day, or approximately 70 trucks.

Elevator "C" receives 100 SU-2's during a peak day, each carrying 12,000 to 30,000 pounds of grain. The grain comes from area farms within 20 miles of the elevator. A feed mill is located next to the elevator which produces 300 tons of meal per day. About 45 percent of the meal is shipped by rail.

3.2.5 **Trends.** Figure 3.2.4 indicates a fluctuating, yet gradually increasing trend in statewide grain production from 1970 through 1982. (7) This figure also shows a linear regression line representing this 12-year period with the same rate projected through 1985 at 95% confidence.

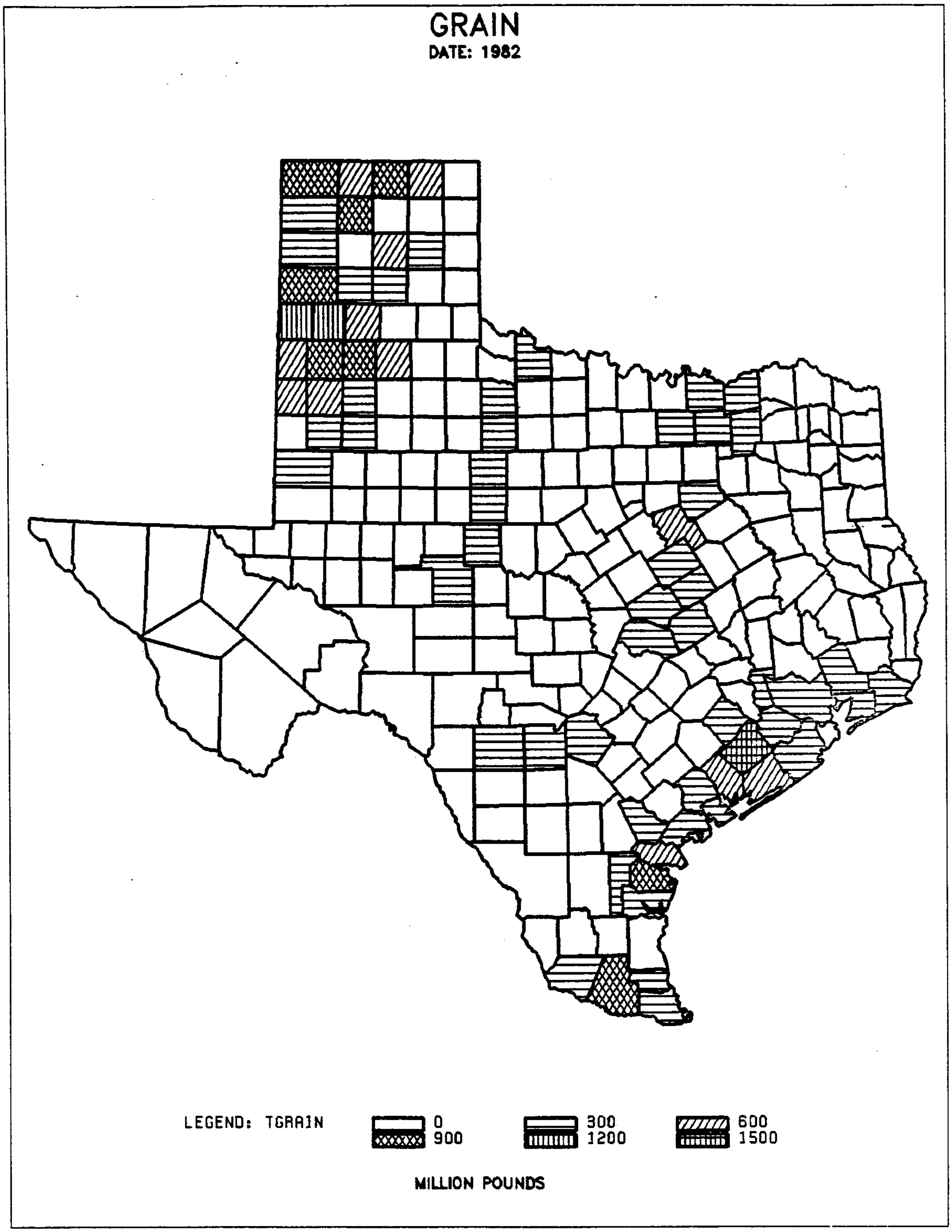
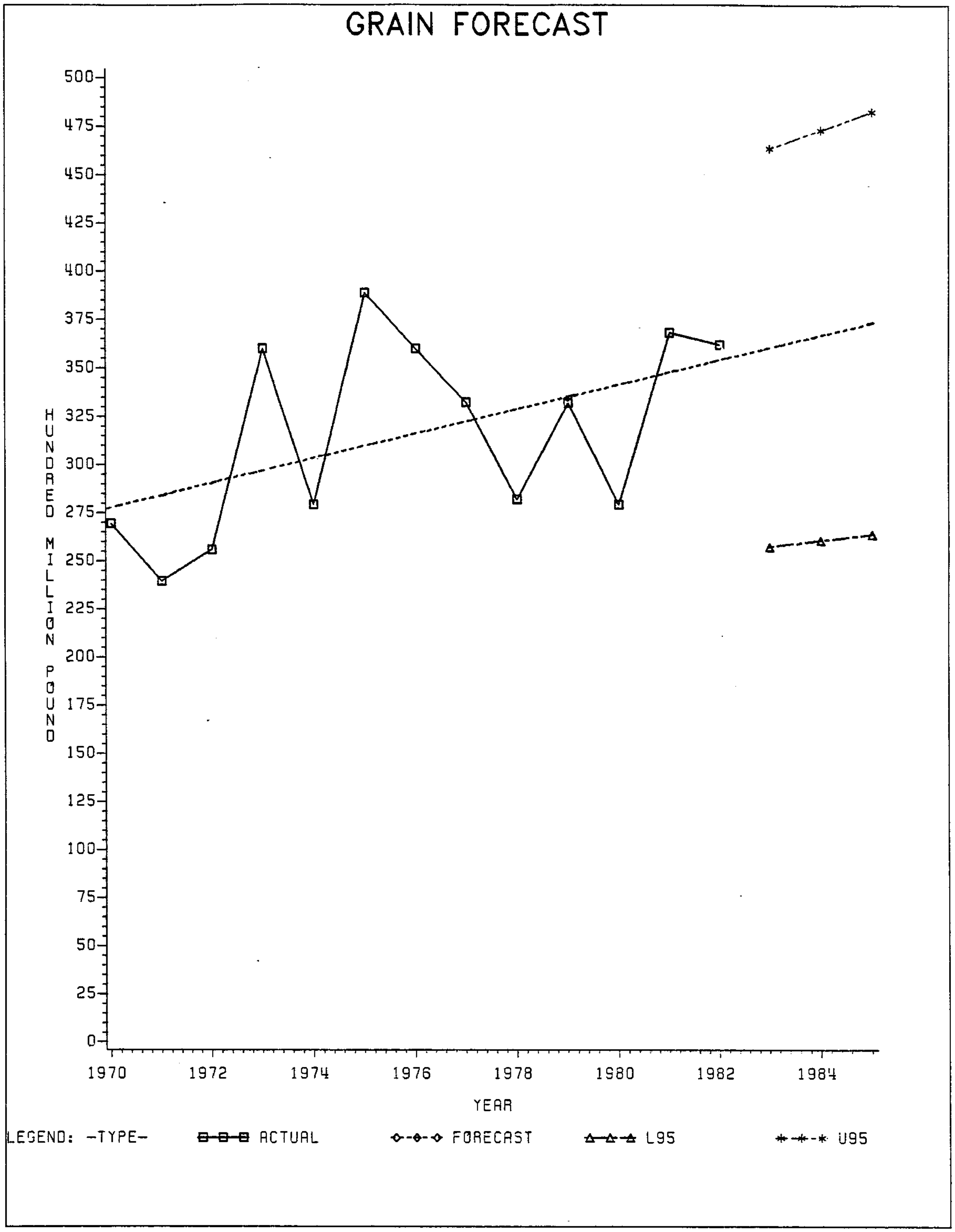


Figure 3.2.3 Location and Intensity of Grain Operations



3.2.4 Trend and Forecast in Harvested Grain

3.3 BEEF CATTLE

3.3.1 Industry Characteristics. The number of cattle expected to be fed in 1984 in Texas feedlots is 5.0 million. (8) This value is higher than in past years due to the bad winter and drought being experienced by the majority of the country. The increase in the number of "placements" (new cattle in a feedlot) has helped Texas in reclaiming the title of "No. 1 cattle feeding state in the nation."

When a cattle owner decides that the calves are ready to be sold, they are most often sent to a feedlot to be fattened for approximately 140 days. A large buyer, such as a major grocery chain, will purchase whole pens of cattle in a single purchase. These cattle are shipped directly from the feedlot to a slaughter plant. Other cattle at the end of their feeding cycle may be sent directly to a cattle auction. The slaughter plant prepares the meat for shipping via refrigerated vans to a multitude of destinations perhaps hundred of miles away. The feedlots, cattle auctions, and slaughter plants are usually located fairly close to each other (average distance of 30 to 40 miles apart), and 100 to 600 miles from the origin of the calves.

The single most important factor which influences the movement of cattle by truck is economics. Neither the weather in the Panhandle nor the characteristics of the cattle industry, produce a variation in beef cattle operations. Economics, on the other hand, can dictate the number of cattle in the feedlots at a given time. If the market is good for beef, owners will be willing to place their cattle in the feedlots to bring a higher price. If the market is tight, the owner will try to fatten the cattle on his own land or leave them in the feedlot for a shorter time before placing them on the auction block.

3.3.2 Flow Chart/Location Map. A flow chart which shows the processing of beef cattle from the producers to the markets is shown below in Figure 3.3.1.

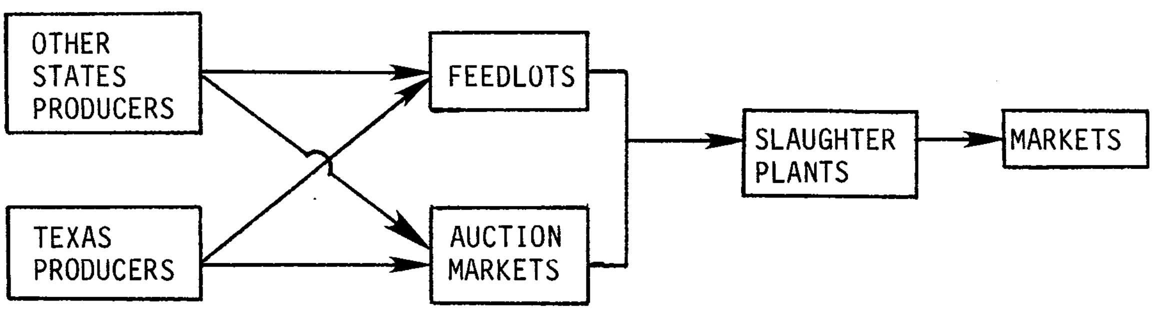


Figure 3.3.1 Beef Cattle Flow Chart

Beef calves come from almost every county in the state with the leading county, Leon, having 80,000 head or 1.3 percent of the state's total as of January 1, 1983. Many calves are brought from out of state from as far as 600 miles away.

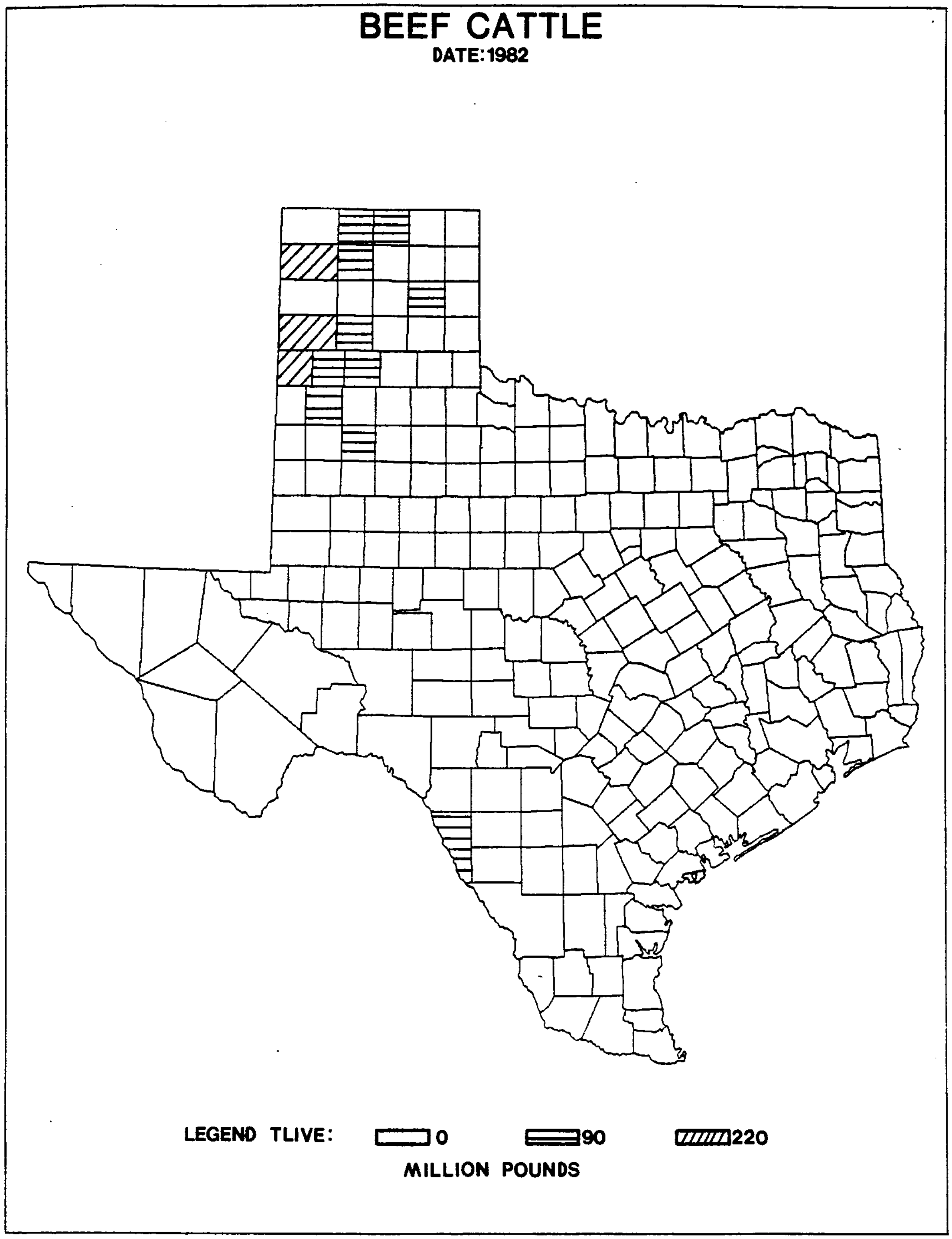
The market for fed cattle is extremely different, however, in that only 13 counties feed most of the cattle fed in Texas. Twelve of these counties are located in the Panhandle as shown in Figure 3.3.2. Deaf Smith County is the state leader, followed by Parmer, Hartley, Hansford, Swister, Moore, Castro, Sherman, Randall, and Lamb Counties. These ten leading counties represented 63 percent of the total statewide fed cattle marketings during 1982. (9)

3.3.3 Truck Characteristics. The vehicle used almost exclusively to transport cattle is the 3-S2. The trailer is known as a "possum belly" trailer and is typically 40 feet long and 12 to 13 1/2 feet high with dual platforms. Smaller vehicles, such as a farm truck pulling a gooseneck trailer, are sometimes used to transport a few cattle for a short distance. Approximately 85 to 90 calves are in the 3-S2 when it arrives at the feedlot. At the end of this cycle, 45 fed cattle are loaded onto the truck for shipment to the cattle auction or slaughter house. (8) It should be noted that rail is not used anywhere in this process. This is because, according to law, the cattle have to be fed and watered periodically. Providing for the cattle is not usually a problem when transporting by truck because of faster movement. The time factor is also critical after slaughter; therefore the beef is transported by a 3-S2 refrigerated van.

3.3.4 Vehicular Trips Generated. A large feedlot has a capacity between 40,000 to 60,000 head of cattle. Since cattle are fed on a 140-day cycle, there is much truck activity for hauling feed as well as calves and fed cattle. Rail use is minimal. Average daily truck requirements for feed coming into this lot are 35 to 40 3-S2's. The average number of loaded 3-S2 vehicles leaving per day with fed cattle is 8 to 10. Approximately 50 employees are needed at a feedlot of this size. A total of 110 to 140 daily passenger car (PC) trip-ends result.

An average size feedlot has 20,000 to 40,000 head capacity. The same 140-day cycle is still used to fatten the cattle. The number of trucks entering a feedlot of this size during each cycle are: 330 to 340 3-S2 loads of feeder cattle, 340 to 350 SU loads of silage, and 1,350 to 1,400 3-S2 loads of corn, with 660 to 670 3-S2 loads of fed cattle leaving the feedlot. In summary, the number of loads entering an average feedlot per day are 15 to 20 3-S2 and 3 to 5 single unit trucks, with 5 to 9 3-S2 loads leaving.

In order to determine an approximate number of truck trips generated by a given feedlot during the 140-day feeding cycle, only the capacity or number of cattle being fed for the feedlot must be known. The following formulas were used in the "1982 Feedlot Study" conducted by the District 4 office of the State Department of Highways and Public Transportation: (10)



3.3.2 Location and Intensity of Fed Cattle Marketings during 1982

$$\frac{\text{No. Head (Feeder Cattle)*}}{\text{90 Head/Truck}} = \text{No. 3-S2 trucks entering (Feeder Cattle)}$$

$$\frac{\text{280 lbs. (Silage)/Head x No. Head}}{\text{12 Ton/Trucks x 2,000 lbs/Ton}} = \text{No. SU silage trucks}$$

$$\frac{\text{2,380 lbs. (Corn)/Head x No. Head}}{\text{52,000 lbs./Trucks}} = \text{No. 3-S2 trucks w/corn}$$

$$\frac{\text{No. Head (Fed Cattle)**}}{\text{45 Head/Truck}} = \text{No. 3-S2 Trucks (Fed Cattle)}$$

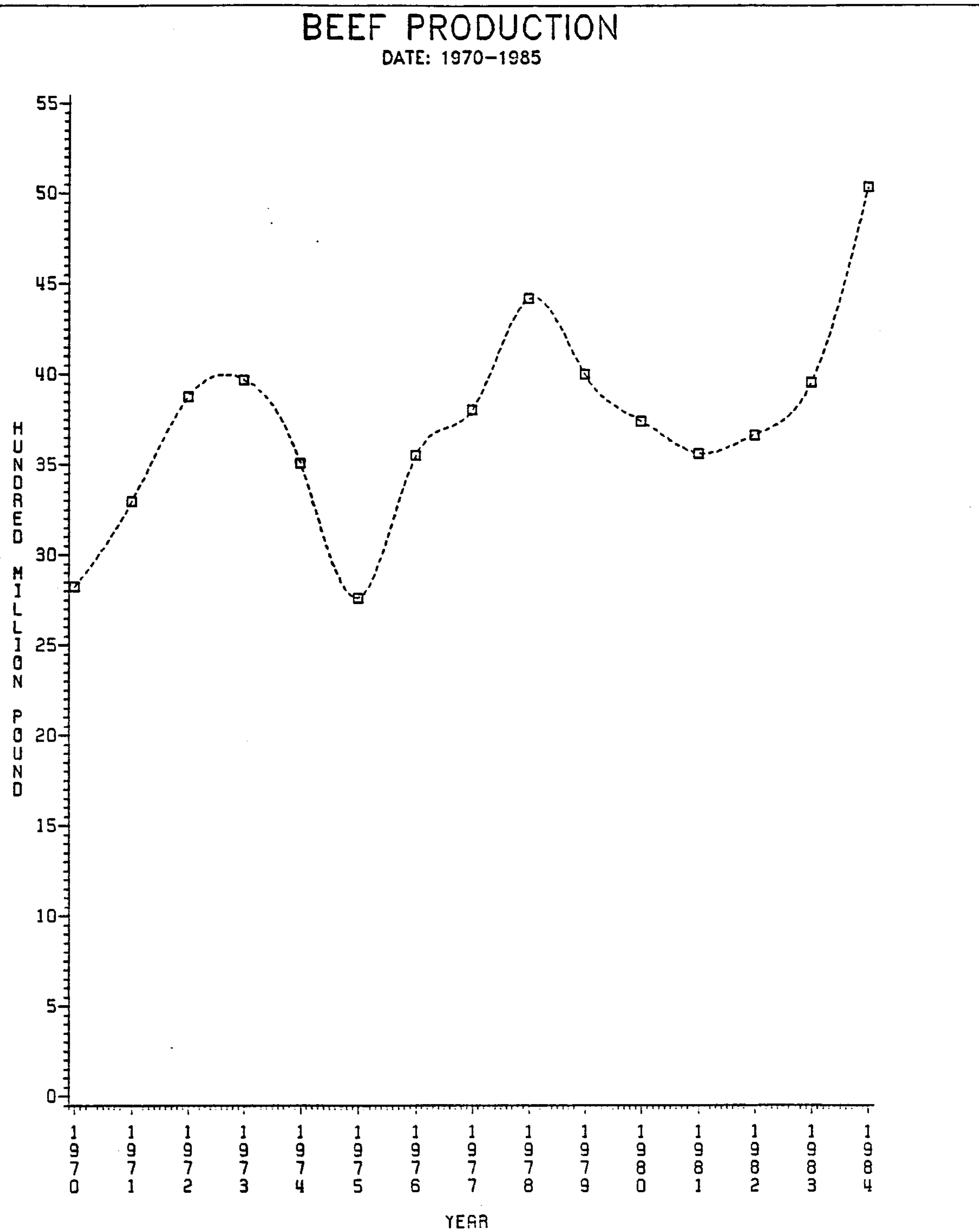
Total No. Truck loads (per 140-day cycle)

*Feeder Cattle - Those brought in to be fed or those being fed.
**Fed Cattle - Those already finished feeding to be hauled to market.

The percentage of loaded 3-S2's which bring feeder cattle to a particular feedlot and immediately leave again with a load of fed cattle is not known. However, if this does occur, it reduces the overall number of trips generated. The number of passenger car trips for employee work trips, etc., must also be added to the truck trips to determine total trips.

A small feedlot has a capacity of less than 20,000 head of cattle per feeding cycle. Small feedlots do not always have the same 140-day cycles. Some cattle are fed for a year on feed that does not fatten the cattle as quickly. The smaller operations are often part of the family-run farm. An average of 10 to 15 trucks enter this type of feedlot per day.

3.3.5 Trends. The number of cattle fed has fluctuated, but each cycle is somewhat higher than the preceding cycle with peaks of 4.4 million in 1973 and 4.9 million head in 1978. A maximum is expected in 1984 of 5.0 million; a levelling off to 4.5 million is expected in the near future. The general trend is depicted in Figure 3.3.3. (7)



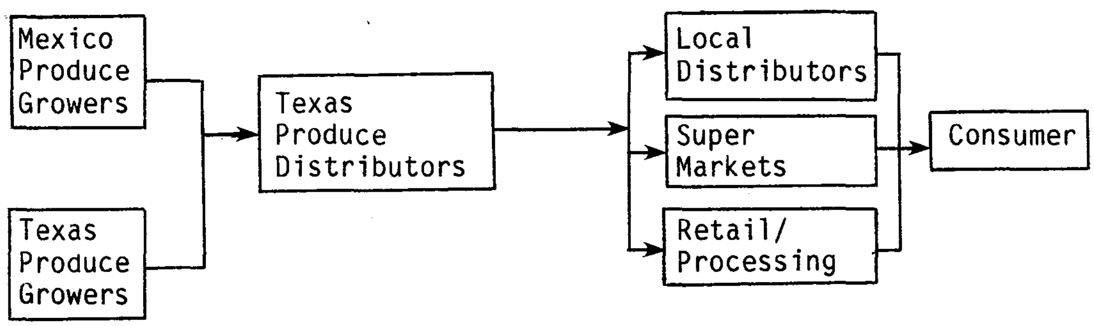
3.3.3 Trend in Grain Fed Cattle

3.4 PRODUCE

3.4.1 Industry Characteristics. The specific vegetables included in Texas produce are: broccoli, cabbage, cantaloupes, carrots, cauliflower, sweet corn, cucumbers, honeydew melons, lettuce, onions, bell peppers, potatoes, spinach, sweet potatoes, tomatoes, and watermelons. The only fruits included in this study are oranges and grapefruit. Of all the special users included in this study, produce involves the simplest distribution process. Single unit trucks or farm trailers are loaded by hand in the field where the fruit or vegetable is grown. This vehicle then travels 5 to 50 miles on public roads to a local distributor. The distributor packages or crates the produce and loads it into a refrigerated van (3-S2) which is owned by a private owner/contractor. This van carries the produce sometimes hundreds of miles to a supermarket warehouse for immediate distribution or possibly to a processing plant for canning.

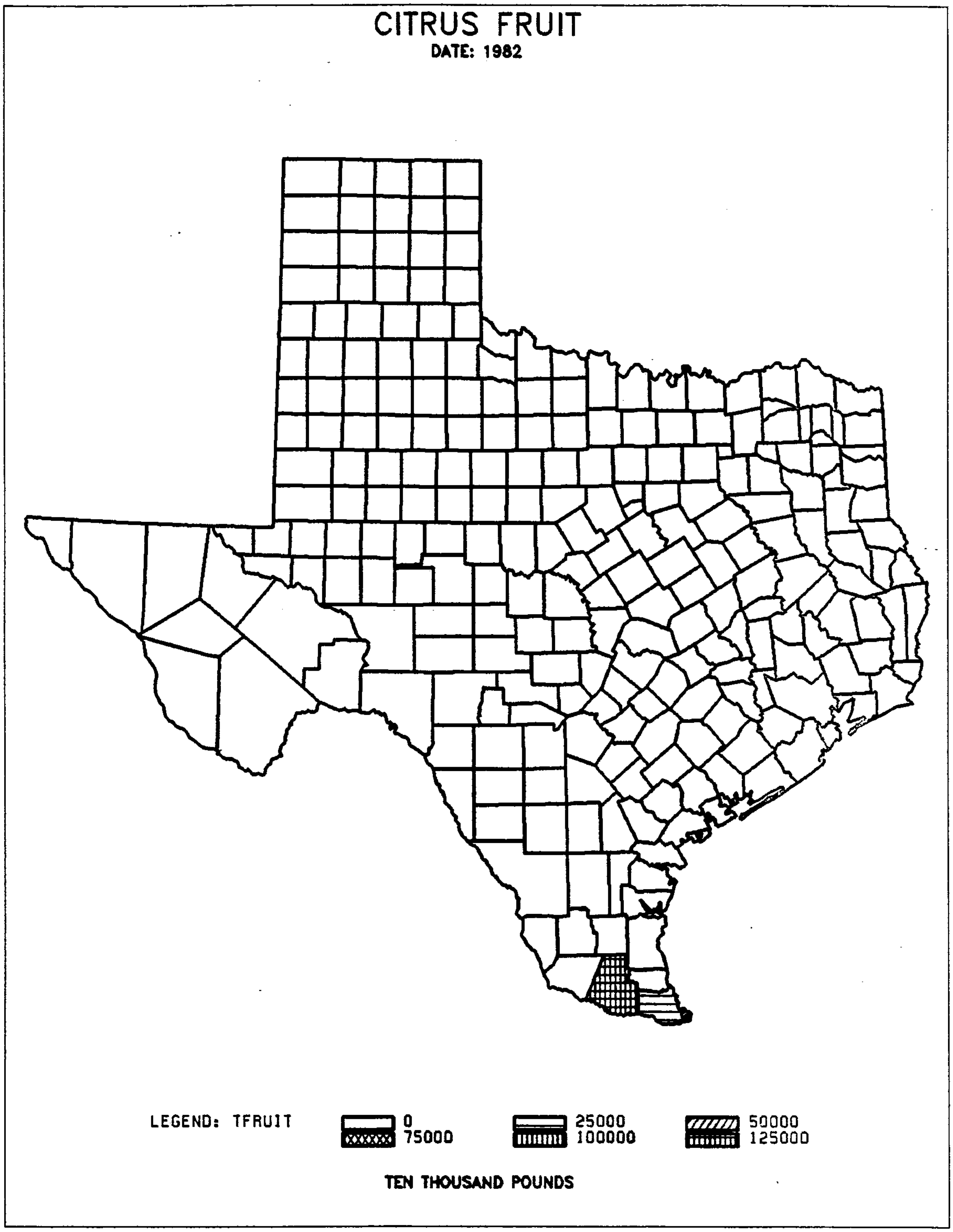
Harvesting for different produce occurs during different times of the year; therefore, produce trucks are somewhat constant throughout most of the year. A small peak occurs during March and April, and a small decline in truck traffic occurs in the Fall around August and September. Weather is a major influence on the movement of produce by truck. If the yield is high due to good weather, then more truck loads are required. The opposite is true during bad weather. For example, the 1983 freeze devastated the Texas citrus crop which meant that no trucks were hauling citrus in 1984.

3.4.2 Flow Chart/Location Map. A flow chart which shows the processing of produce from the fields to consumer is shown in Figure 3.4.1.

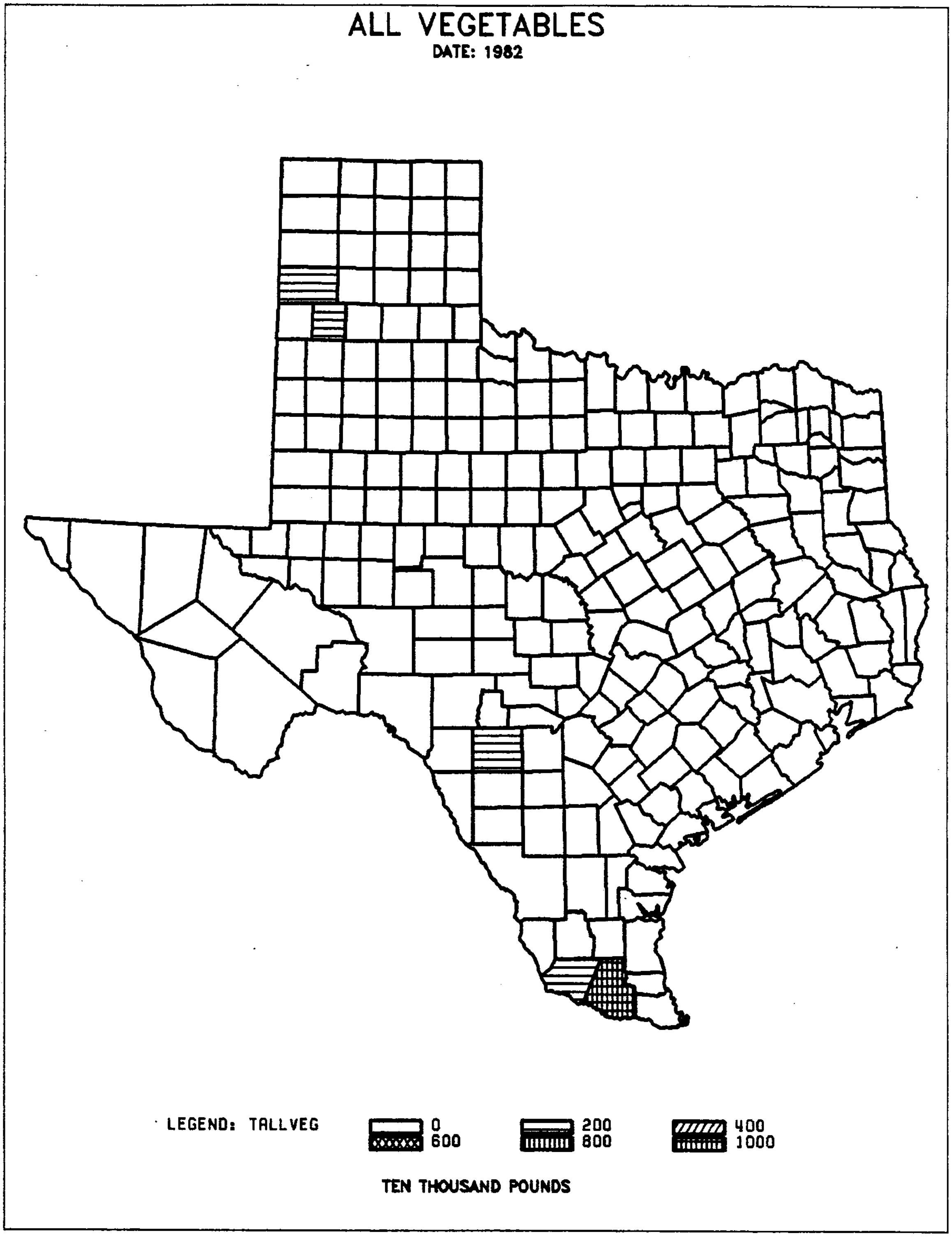


3.4.1 Produce Flow Chart

Although Texas produce is concentrated in the Rio Grande Valley area, other areas are producers of certain specific commodities. The primary areas are indicated in Figures 3.4.2 and 3.4.3, (7) with other less intense activities in the High Plains area, the East Texas area around Wood and Van Zandt Counties, and the Winter Garden area which includes Dimmitt, Frio, Kinney, LaSalle, Maverick, Uvalde, and Zavala Counties. In the Rio Grande Valley, Hidalgo County is the leading Texas County in vegetable acreage harvested, followed by Starr and Cameron. Other leading counties are Frio and Uvalde located in the Winter Garden area, and Floyd and Castro located in the High Plains (See Figure 3.2.1). Texas citrus fruit comes from Hidalgo, Willacy, and Cameron Counties in the Rio Grande Valley. (11, 12)



3.4.2 Location and Intensity of Citrus Fruit



3.4.3 Location and Intensity of All Vegetables

3.4.3 Truck Characteristics. Farmers use the most economical means of transporting their produce to the distributor. This may be single-unit trucks or two- or three-axle trailers pulled by a tractor. The latter is obviously for a shorter haul distance. From the distributor, the produce is carried by 3-S2 refrigerated vans. No rail is used to move Texas produce.

3.4.4 Vehicular Trips Generated. The activity center chosen for study was the distributor, the first point of processing after the produce leaves the field. The distance between the fields and the distributor is 15 to 50 miles. As earlier mentioned, since the 1983 freeze completely destroyed the citrus crop in Texas, the movement of citrus fruit could not be adequately determined in this initial phase of the study.

A large distributor of produce receives an average of 200 vehicle-loads (SU-2 and field tractor pulling one or two field trailers) per day during the shipping season. The average number of 3-S2 truck loads leaving are 75 to 100 per day, with a maximum of 200. The number of employees are 200 to 250 who work one shift, 8 a.m. to 6 p.m.

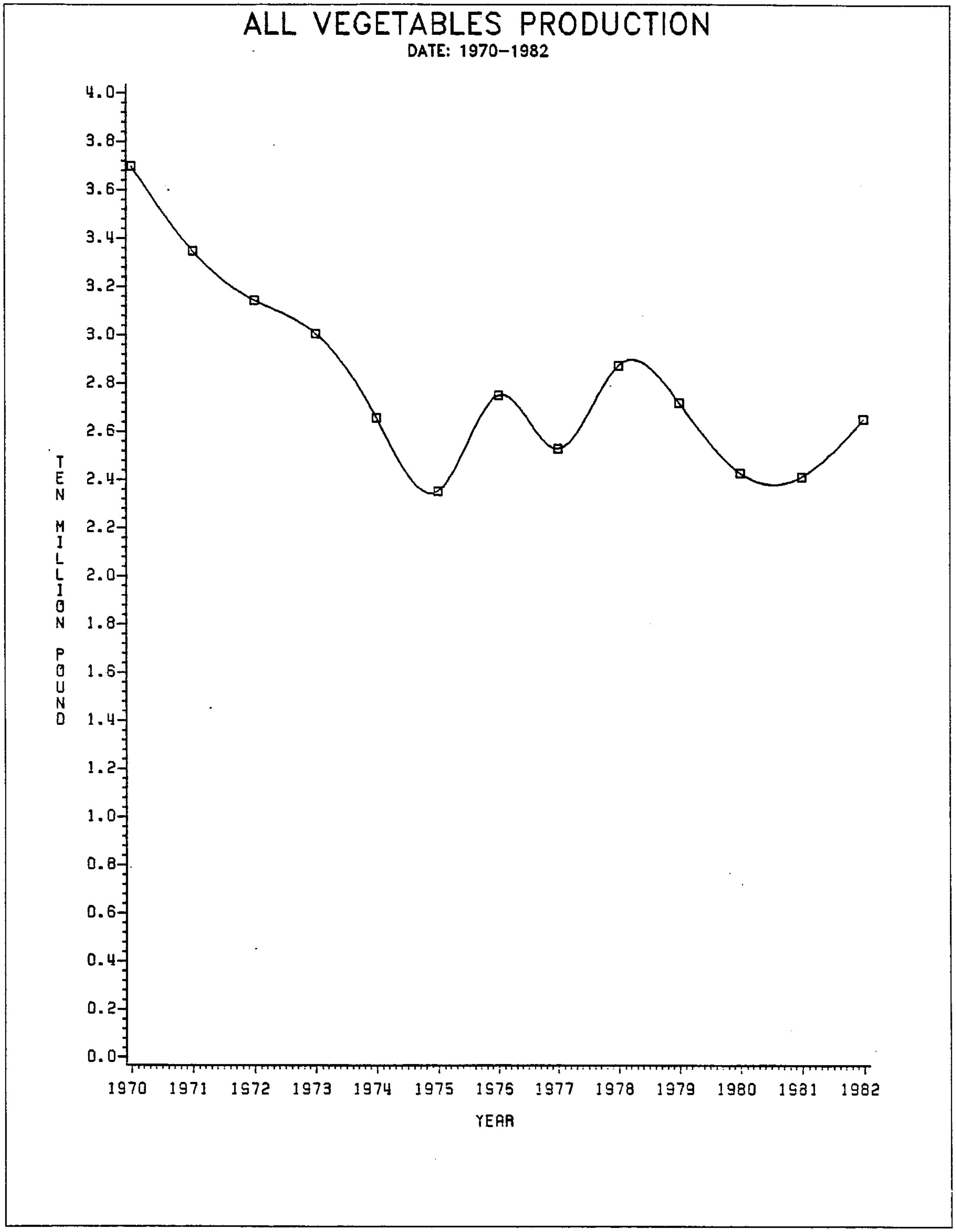
An average size distributor receives 40 to 45 loaded field vehicles per day. These arrivals are fairly constant from 11 a.m. to 4 p.m. The SU-2 (3-axle "bobtail") trucks are very commonly used to haul from field to distributor. The bulk of 3S-2 loaded refrigerated vehicles leave a distributor between 2 p.m. and the early morning hours. A peak appears to occur around midnight.

Texas was among the top three leading states in harvested acreage of principal vegetables for fresh market for 1981 through 1983. The number of harvested acres in 1982 was 67,300 and in 1983, 63,200 acres--second only to California and Florida in both years. This acreage produced a total of approximately 10.617×10^8 pounds of produce in 1982 and 11.327×10^8 pounds in 1983 which was hauled on public roads. In 1983, this represented a total of approximately 57,000 SU loads from field to distributor and 23,000 3-S2 loads from distributor to market place. An additional 18,000 to 20,000 loads per year are brought to Texas distributors in the Rio Grande Valley from Mexico. (12)

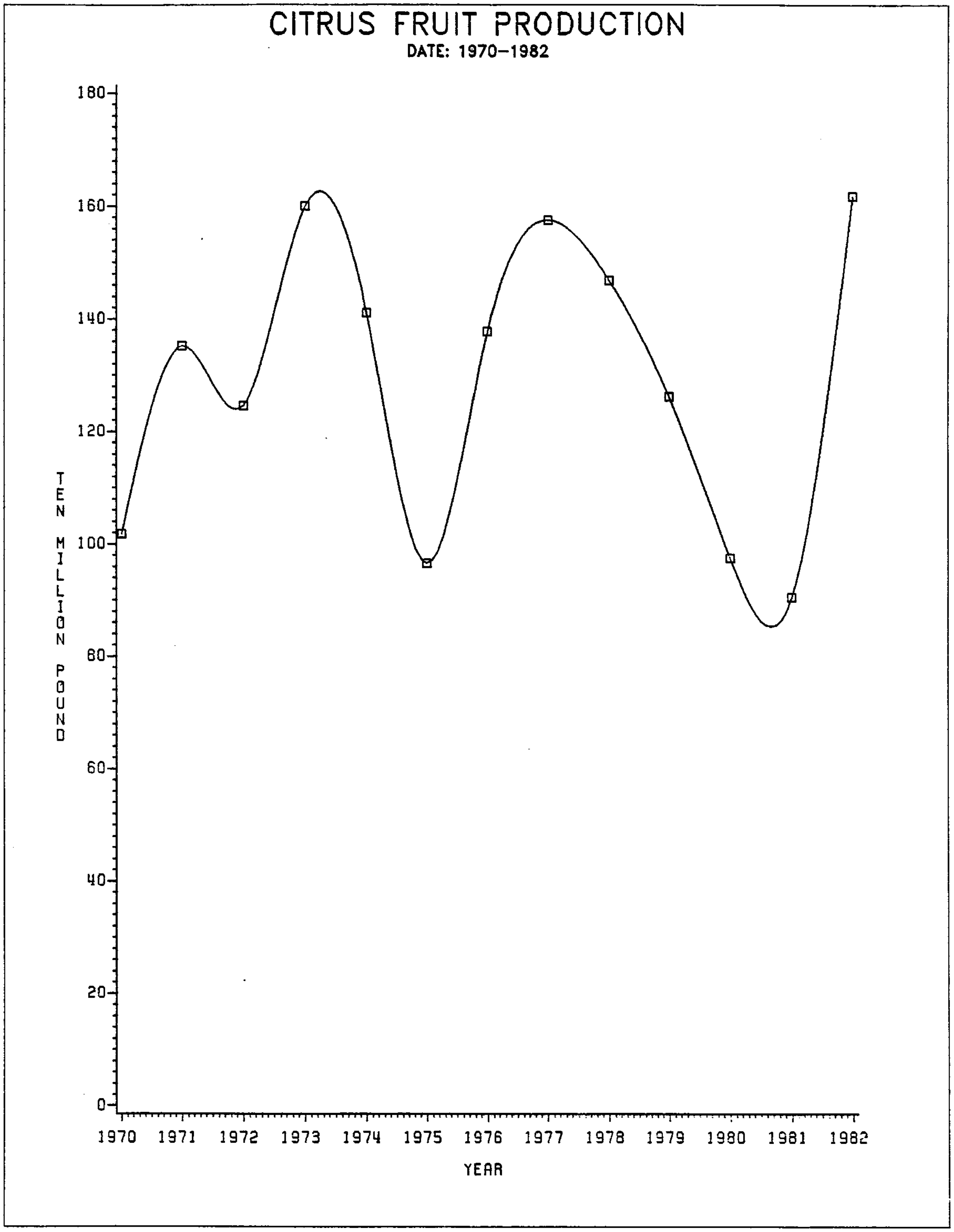
3.4.5 Trends. The trend in vegetables produced in Texas is shown in Figure 3.4.4. This indicates a gradual decline from 3.7×10^7 pounds shipped in 1970 to about 2.5×10^7 pounds in 1982. Texas was third in the nation in 1983 in harvested acreage of principal vegetables for fresh market, led by California and Florida.

Citrus and peaches are the largest of the fruit crops in Texas. Since the quantity of peaches grown in the state is not considered significant in comparison to citrus, peaches will not be included in this study. The primary locations for citrus are Cameron, Hidalgo, and Willacy Counties with other smaller groves in Brooks, Dimmitt, Starr, Webb, and Zapata Counties. (11)

The yearly production of citrus beginning with 1970 is shown in Figure 3.4.5. (7) Because of the 1983-1984 citrus crop freeze, a time period of 4 to 5 years will be required before more fruit can be harvested.



3.4.4 Trend in Total Vegetable Production



3.4.5 Trend in Citrus Fruit Production

3.5 POULTRY

3.5.1 Industry Characteristics. Broilers/fryers, as commonly found in supermarkets, are now produced by a few major corporations. All of the growing of poultry is done by contract, i.e., the feeding, veterinary, and other services. In the state of Texas, the hatchery is typically near the location where the chicks are fed. The distance between the two rarely exceeds 25 miles.

Each "production unit" where chicks are fed has 15,000 birds. At one day old, the chicks are brought to a production unit or "house" and are fed from 47 to 53 days, at which time they are hauled by truck to a central processing facility.

The central processing facility, if working on an 8-hour shift basis, can handle 50,000 to 65,000 birds per day. For two shifts which run from perhaps 7:00 a.m. to midnight, a total of 120,000 to 150,000 chickens per day can be processed. From the processing plant, the broilers/fryers are sent to a distribution warehouse, then to supermarkets or other receivers.

3.5.2 Flow Chart/Location Map. A flow chart which shows the processing of poultry from the hatchery to the consumer is shown below in Figure 3.5.1.

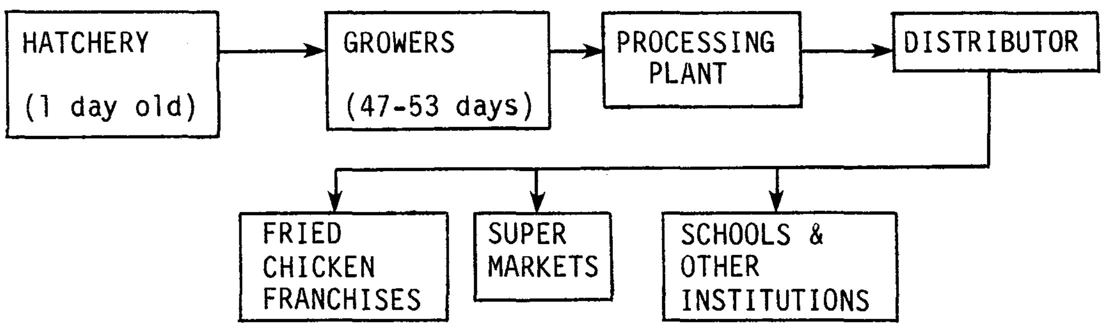


Figure 3.5.1 Poultry Flow Chart

Commercial broilers are produced primarily in East Texas as shown by Figure 3.5.2. The leading county is Nacogdoches County, with 94 percent of the state's production in the counties of Nacogdoches, Gonzales, Shelby, Camp, Panola, Upshur, Titus, San Augustine, Sabine, and Wood. (9)

3.5.3 Truck Characteristics. Baby chicks at one day old are transported from the hatchery to the grower. The vehicle-type used by one firm to do this is an old school bus which provides protection to the chicks during inclement weather. During the 47 to 53 day growing cycle, there will be 6 to 7 trips made by a service man in a single-unit truck and 5 or 6 trips by the feed truck. The vehicle used to haul grown chickens from each processing unit or "house" is the 3-S2 with flat-bed trailer. After processing, the broilers are hauled by 3-S2 vehicles with refrigerated vans.

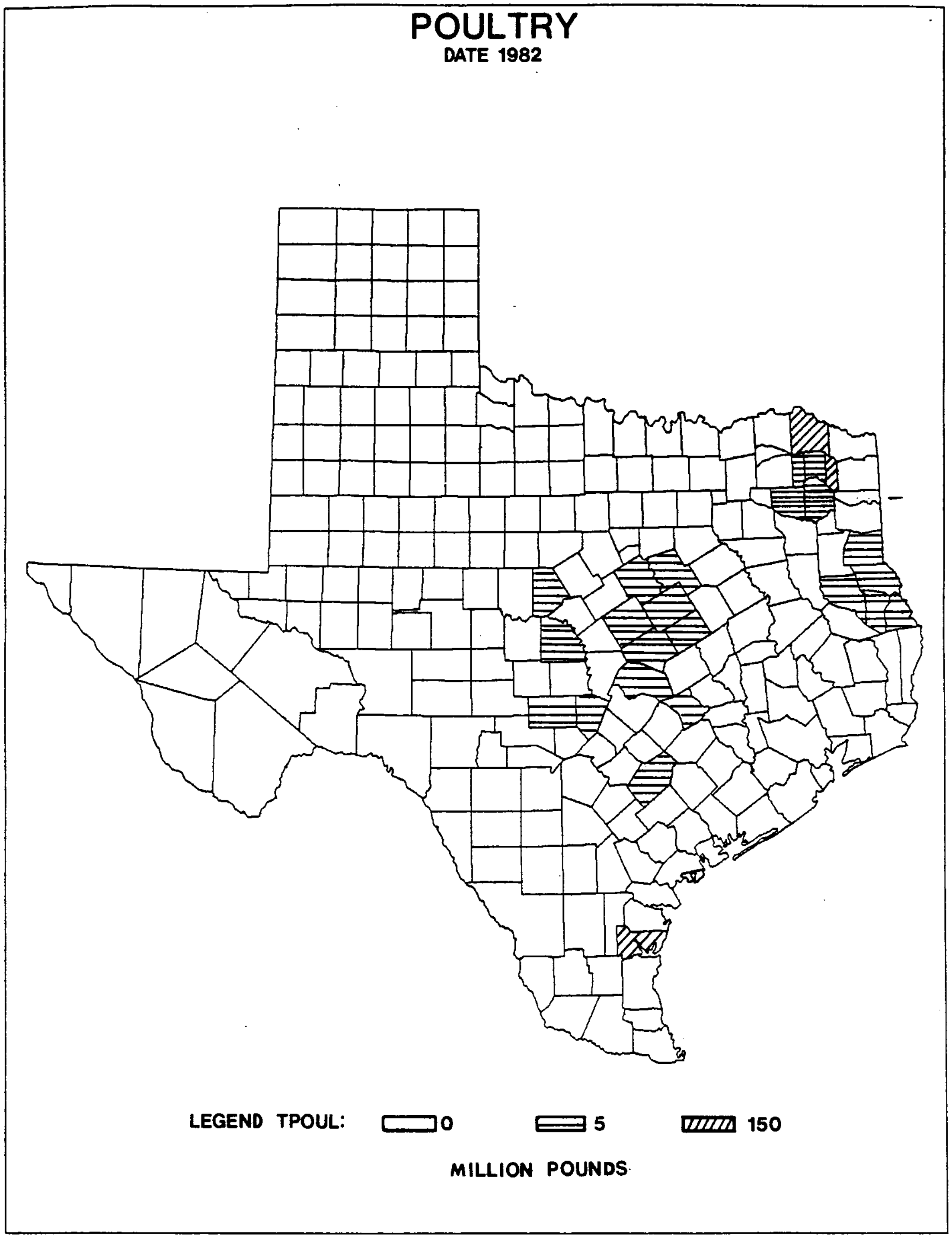


Figure 3.5.2 Location and Intensity of Poultry Activities

3.5.4 Vehicular Trips Generated. During the 47 to 53 day growing cycle, only 6 to 7 trips are made by a service man in a single-unit truck and only 5 to 6 trips made by the feed truck. Since the processing plant is a much higher trip generator, it was chosen as the activity center for the study. During an 8-hour shift, approximately 65,000 to 70,000 birds can be processed, which is roughly nine 3-S2 loads coming in. For a two-shift operation, approximately 18 to 19 loads come in during an average day. The number of refrigerated vans leaving on an average day are: 6 for a typical single shift operation and 12 for a typical two-shift operation. A prominent poultry producer in the state has 3 processing plants and a total of four 8-hour shifts in operation. The following number of one-way trips are generated on an average day for all four of these 8-hour shifts:

* 80 3-S2 trips (40 loads) of live birds,
* 50 3-S2 trips (25 loads) of dressed birds leaving,
* 1,400 passenger car trips by employees

The truck trips are randomly spaced with some exceptions due to weather. During the hot summer months, from June through the first half of September, the chickens are caught and loaded from 10 p.m. to 11 a.m. This is to avoid the hotter temperatures which would make this activity more difficult. During the remainder of the year, the chickens are hauled just before processing is scheduled to begin. No rail is used in the poultry industry except for delivery of grain and feed to the growers.

3.5.5 Trends.

A gradual increase in the number of birds grown in the state from 1970 through 1982 is shown by Figure 3.5.3. (7) The location of laying hens and pullets and their number are not considered in this study.

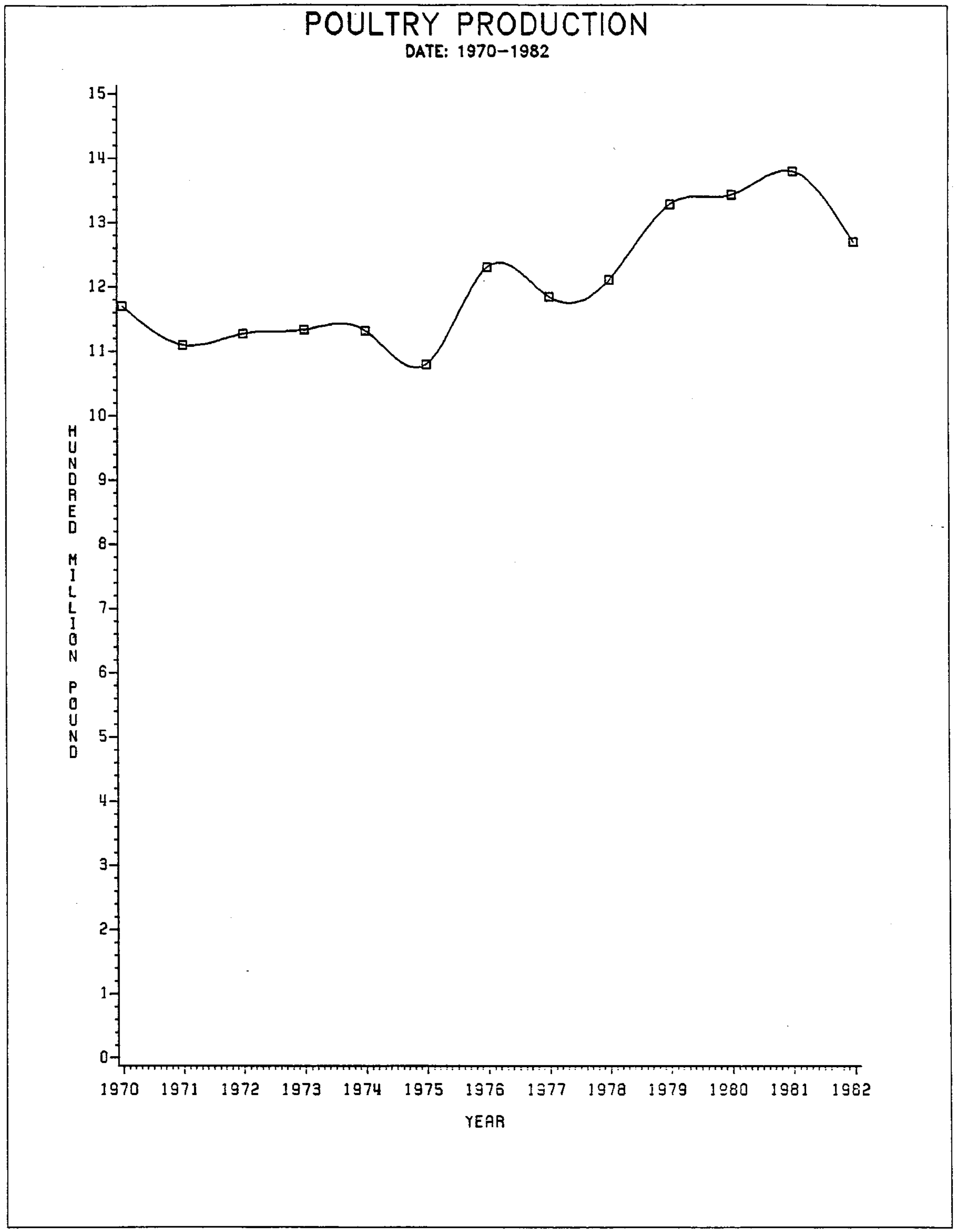


Figure 3.5.3 Trend in Poultry Industry

3.6 COTTON

3.6.1 Industry Characteristics. Cotton is picked or stripped in the field by a mechanical cotton picker and prepared for transporting to the cotton gin. A recent development in this phase of cotton production involves the formation of "modules" of this seed cotton for transporting to the gin. Previously, the farmer loaded all cotton into a cotton trailer which was then pulled to the gin by a pickup truck. This trailer would then be left at the gin until the ginner unloaded all the trailers ahead of it. Obviously, the farmer had to purchase, or have access to, several of these trailers in order to keep his harvesting operation running without interruption. A shortage of trailers often occurred, which caused delays in the harvesting process.

The module concept has revolutionized this process. The farmer can now make the modules as the cotton is picked and leave the modules of seed cotton near the field until a module truck can haul them to the gin. The modules are made by a steel form which is hydraulically operated and which compacts about 10 bales of cotton into a "rick." The dimensions of this rick of cotton are 7 1/2 feet in width by 25 to 30 feet in length. When the farmer is ready to sell several modules of cotton, he contacts several gins within a 15- to 20-mile radius to determine the best deal for selling his cotton. The ginner who is selected sends a module truck to the storage site while the farmer continues harvesting. In this case, there is no delay in the harvesting due to a lack of trailers. Approximately 80 percent of the seed cotton is now hauled to the gin in modules, with the remaining 20 percent hauled by cotton trailers.

A bale of picked seed cotton weighs approximately 1,500 pounds, while a bale of stripped seed cotton weighs approximately 2,000 pounds. The picked seed cotton has lint plus seeds whereas the stripped seed cotton has limbs plus lint plus seed. The seeds, lint, and limbs are removed at the gin. Then the bales weighing 480 to 500 pounds are transported on flat-bed trailers to a compress for distribution.

3.6.2 Flow Chart/Location Map. The processing of cotton is as indicated below in Figure 3.6.1. The largest and most intense area for

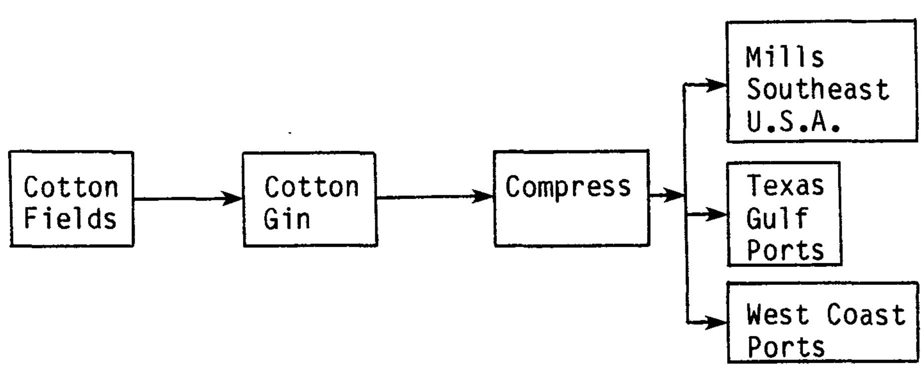


Figure 3.6.1 Cotton Flow Chart

cotton production in the state is the Southern High Plains and part of the Northern High Plains. This is shown by Figure 3.6.2. (7) The cotton shipped from the High Plains area goes generally in three directions. About two-thirds of the cotton is sent to the West Coast and to Texas ports for export. Cotton shipped to the West Coast travels by rail, whereas that shipped to Texas ports and mills in the southeastern United States goes by truck.

3.6.3 Truck Characteristics. The module truck which is now used to haul 80 percent of the seed cotton from the field to the gin is a single unit truck with three axles (AASHTO SU-2). The weight of the empty vehicle is 25,500 pounds and loaded is about 46,000 pounds. The dimensions of the bed made by one manufacturer are 8'-0" by 37'-6". The truck wheelbase is 233 inches. The flat bed is built to be tilted so that the rear end touches the ground. As the truck is backed up to a rick or module of cotton, the bed is tilted, a conveyor system on the bed is turned on, and the truck backs under the load. Therefore, no additional equipment is needed to load the truck. The distance travelled from the field to the gin is usually 15 to 20 miles.

From the gin to the compress is 10 to 100 miles with an average of 45 to 50 miles. The vehicle used to haul the cotton to the compress is the 3-S2 with flat bed trailer. These vehicles haul 50 to 60 bales of flat or uncompressed cotton or about 90 bales of compressed cotton. The percentage of flat cotton hauled is relatively low, at about 20 percent, since most gins now compress their own cotton.

The vehicle used to transport the compressed cotton to mills or ports is the 3-S2. Cotton shipped to the Gulf ports usually is hauled by flat-bed trailers which can haul 90 to 100 bales. On the other hand, cotton hauled to the mills in the southeastern United States usually goes by enclosed van (3-S2). This is simply because many of these vehicles bring a load of some other commodity from the east coast (furniture, etc.) and want to return to the east coast with a load. The vans can haul 80 to 84 bales per load, which is less than the flat beds because of the volume constraint. Cotton goes to the West Coast ports by rail.

3.6.4 Vehicular Trips Generated. For an "average" gin which operates 24 hours per day, approximately 150 bales of cotton or 15 modules can be handled per day. Larger gins can process 500 bales or 50 modules per 24-hour shift. Each module is one SU-2 load coming into the gin. Trucks leaving the gin haul from 50 to 90 bales, and typically haul closer to 90. For an average gin, this means almost two 3-S2 loads leaving per day and for a large gin about six loads. The distance from the field to the gin is 15 to 20 miles, and the distance from the gin to the compress is 10 to 100 miles, or an average of 50 miles.

The cotton compress unloads 300 to 400 3-S2's per day from the area gins and loads 8 to 10 van-type 3-S2's plus 10 to 15 flat-bed 3-S2's during the peak season (which begins on or about October 15 and runs to about January 15). The inbound trucks unload on a 24-hour basis but about two-thirds unload during daylight hours. The outbound vehicles are loaded from 7:30 a.m. to 5:00 p.m. at one compress in the Lubbock area.

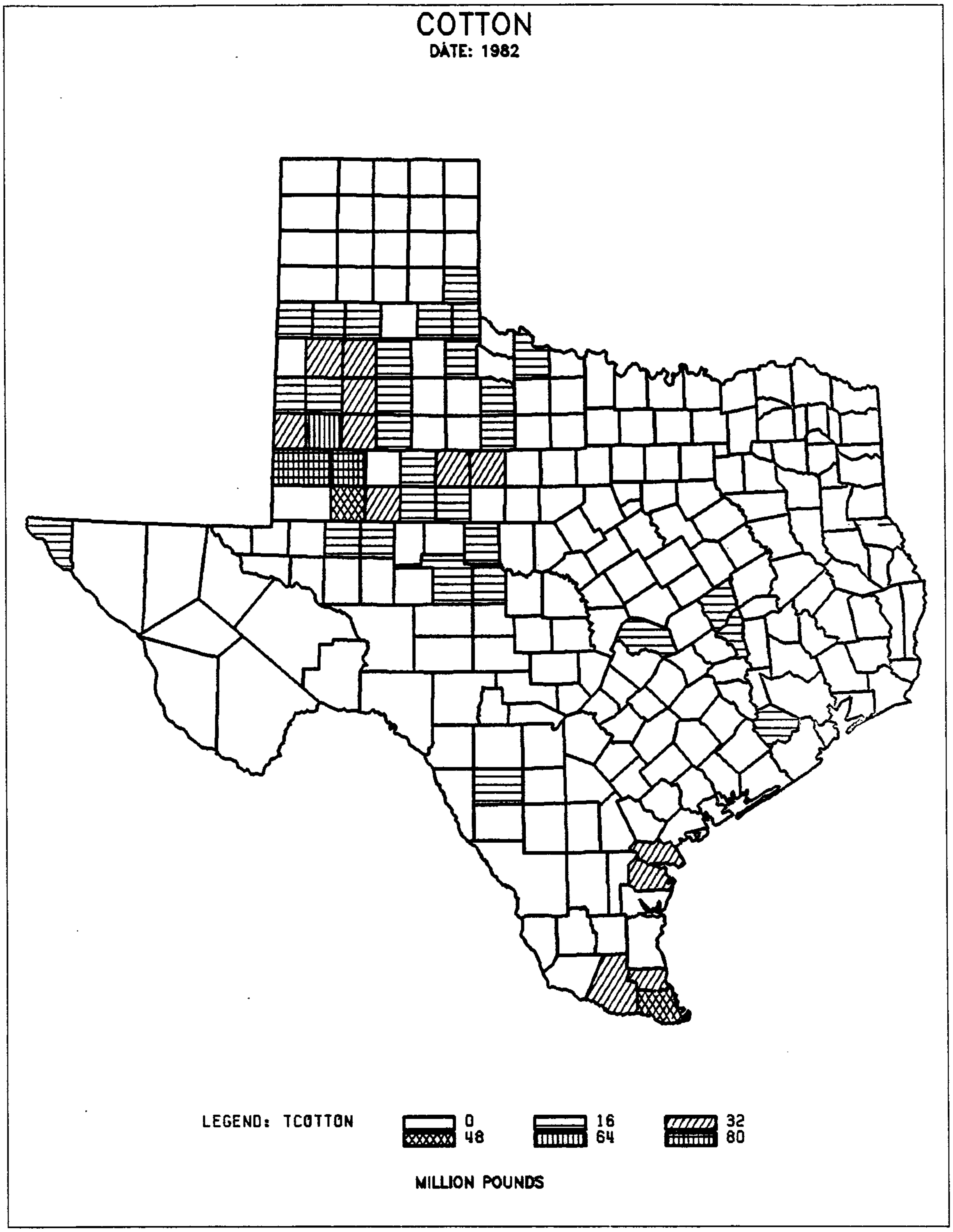


Figure 3.6.2 Location and Intensity of Cotton Harvesting Activities

3.6.5 Trends. The plot of yearly cotton production--Figure 3.6.3--shows significant variation from year to year. (7) Two factors which explain such fluctuations are economics and weather. Texas was the leading state in the production of cotton in 1981 with 5.6 million bales and was second only to California in 1982. (13)

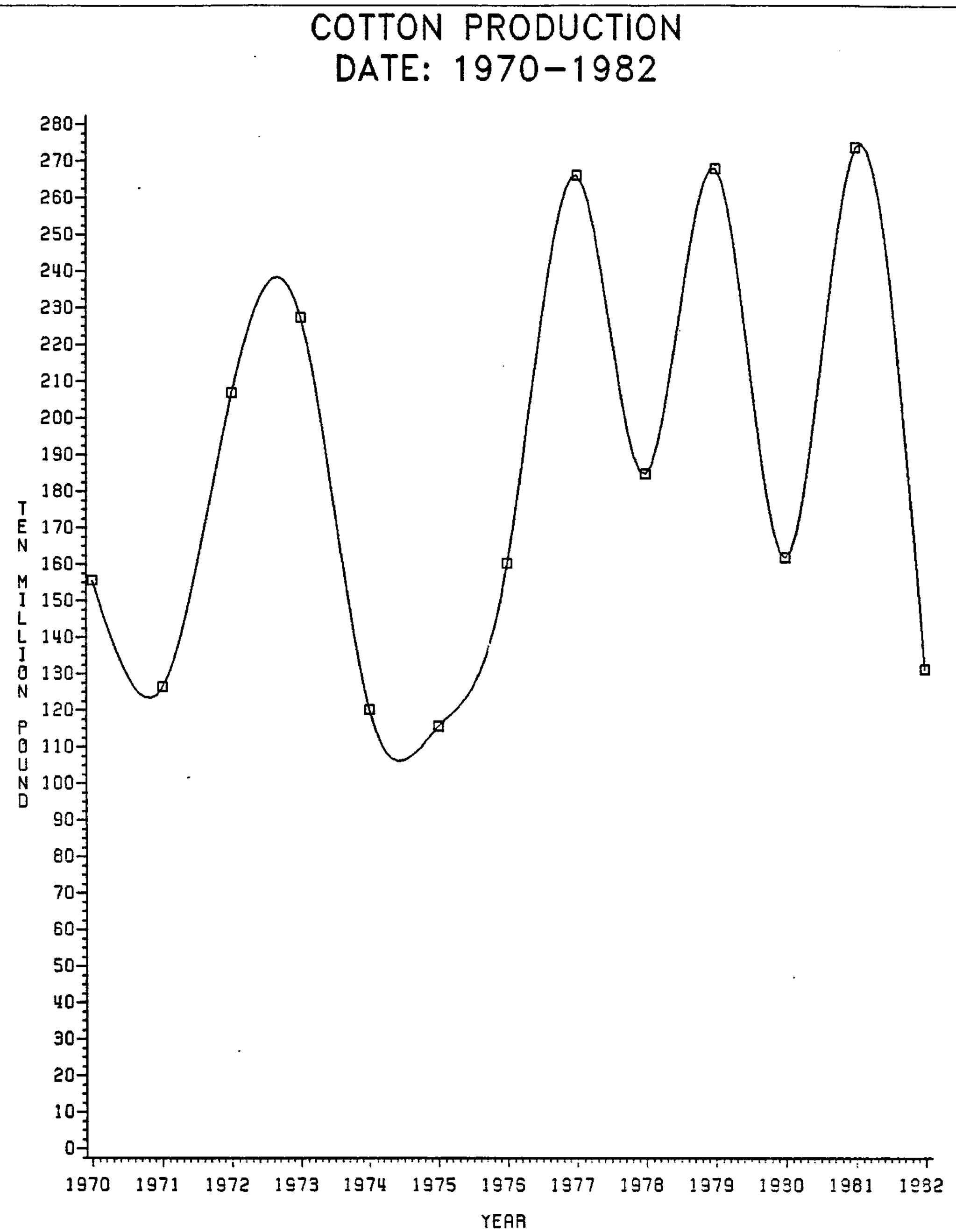


Figure 3.6.3 Trend in Cotton Production

3.7 SAND/GRAVEL

3.7.1 Industry Characteristics. Sand and gravel pit operations are located along river banks or in areas where a river has changed its course and deposited gravel along its previous course. After the overburden is removed, a dragline is positioned next to the deposit and scoops material to be loaded onto trucks. These trucks use private roads to haul this material to a machine which cleans and separates the usable material from the waste material. The good material is loaded onto trucks and hauled over public or private roads to a construction site, an asphalt plant, or a concrete plant. These plants use the raw material to make a product that will be shipped by truck to its final destination. The average travel distance between the gravel plant and the user is 60 miles.

A major influence on the sand and gravel industry is economics. When the economy is down, construction is down, and therefore the demand for sand and gravel is also down. No real peak season exists for sand and gravel, but winter weather causes a slight reduction in the amount of sand and gravel being moved.

3.7.2 Flow Chart/Location Map. A flow chart which shows the processing of sand/gravel from the pit to the consumer is shown below in Figure 3.7.1. Counties reporting sand and gravel production to the U.S. Bureau of Mines in 1980 are shown in Figure 3.7.2. (14)

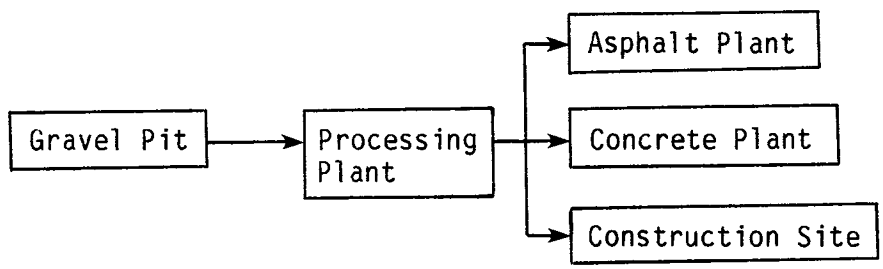


Figure 3.7.1 Sand/Gravel Flow Chart

3.7.3 Truck Characteristics. The primary vehicle used in the sand and gravel industry is the 3-S2 type truck. Typically, the gravel trailer is 31 to 34 feet in length with a hydraulic system for raising the front of the trailer to dump the load. The exception to this dumping system is a bottom dump trailer used in isolated cases in the tractor/semitrailer/trailer combination (double-bottom).

Another truck used in this industry is the SU-2 vehicles often pulling a trailer or "pup," although this is not as common as the 3-S2. These vehicles typically cannot legally gross 80,000 pounds due to the short wheelbase. In Texas, the "bridge formula" (Appendix, Section 7.3) establishes legal gross weights according to wheelbase. These trailers (3-S2) are 31 to 34 feet in length and therefore allow a gross weight of 69,000 to 74,000 pounds. Transporting of sand and gravel by rail is often not feasible, since the pit location is sometimes too far from existing rail lines and the resource deposit is not large enough to justify the expense of

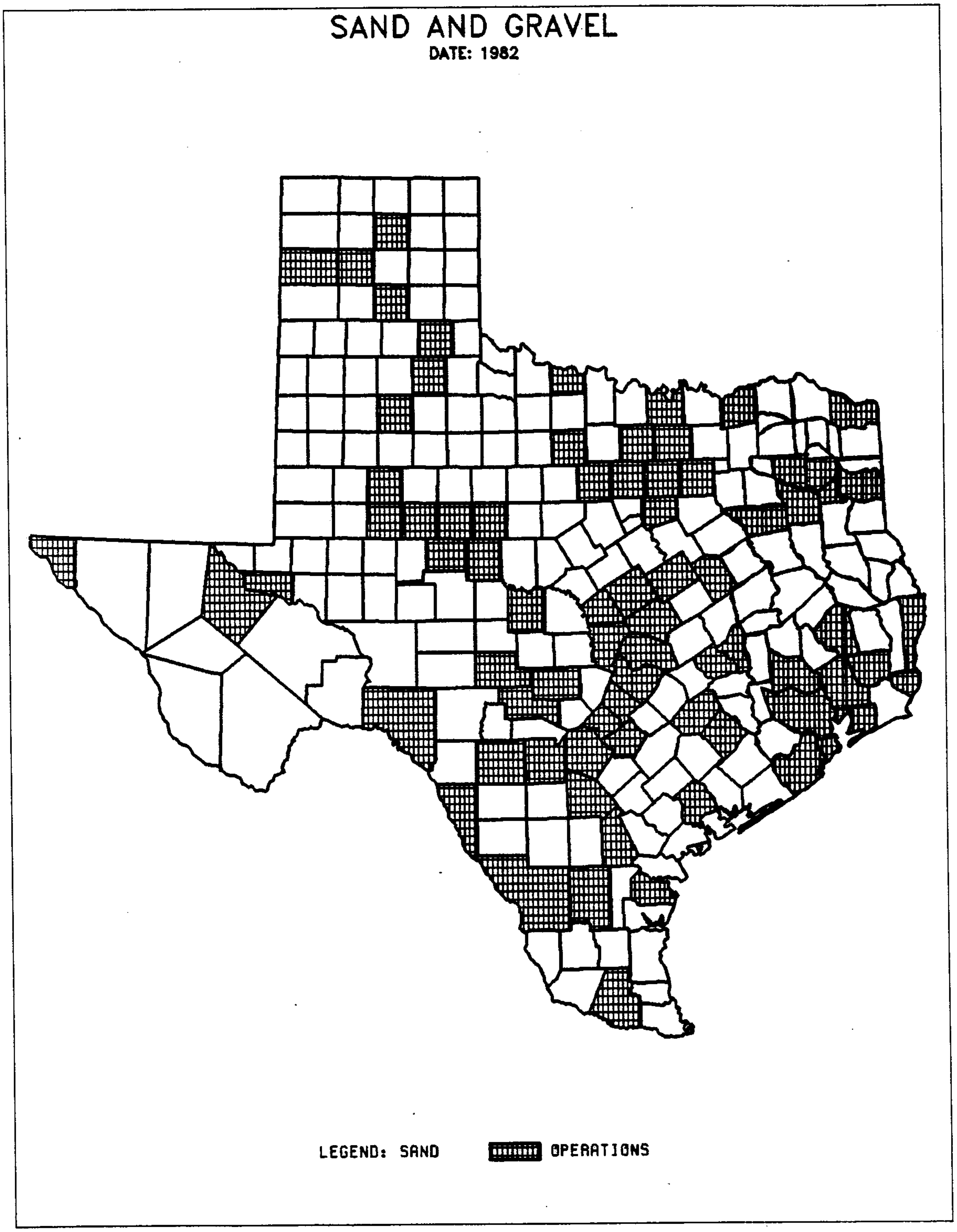


Figure 3.7.2 Location of Sand/Gravel Operations, 1980

building a spur. Sand and gravel are hauled on public roads from the mining area to the construction site or to asphalt batch plants or concrete plants.

3.7.4 Vehicular Trips Generated. Most vehicles hauling from this pit are 3-S2 with 31- to 34-foot trailers which are shorter than the 40- to 45-foot trailers used in other industries. Because of their shorter length, these vehicles cannot legally gross 80,000 pounds; therefore, a greater number of trips are required per quantity of material to be moved.

One large sand/gravel operation surveyed has a capacity of 1,250 tons per hour. This equates roughly to 25 trucks per hour leaving the pit or 370 truck loads per day. The maximum possible per day is 550 loads. The average distance traveled per day per truck is 300 miles over a radius of about 60 miles. On an annual basis, this size operation moves about 2.5 million tons of gravel, none by rail. The average plant handles 500,000 to 750,000 tons per year, 60 percent of which is sold immediately and the remainder stockpiled for later use. Over the long term all gravel is sold, but a surplus of sand will remain.

Recent statistics from the Texas Bureau of Economic Geology show that the total annual sand and gravel production for the state of Texas was 45,476,000 tons.

3.7.5 Trends. The production of sand and gravel in the state from 1970 to 1983 is shown in Figure 3.7.3. This indicates a general increase in production from 1970 through 1978, followed by a slow-down through 1982. Production was up again in 1983. (15)

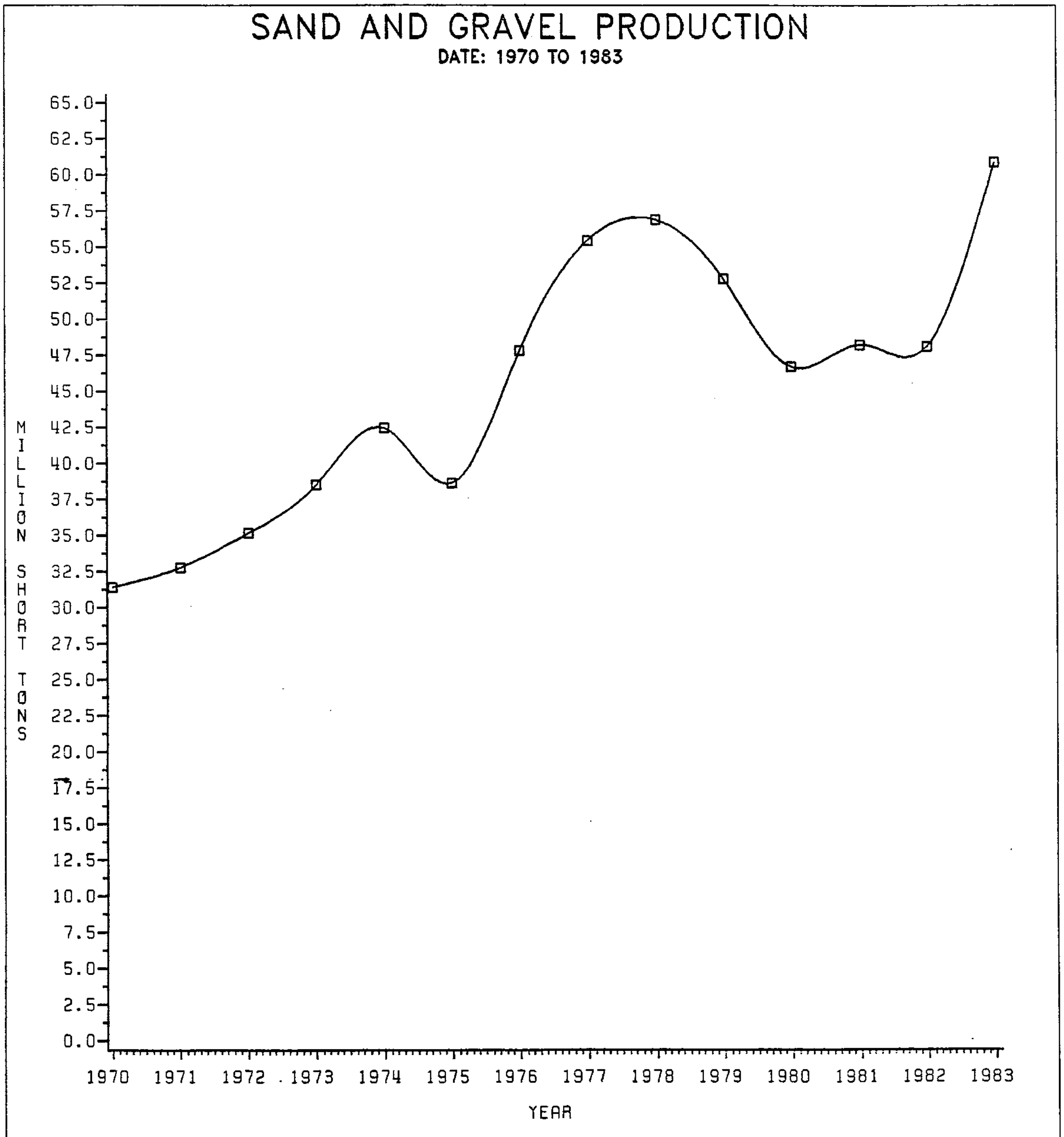


Figure 3.7.3 Trend in Sand/Gravel Production

3.8 CRUSHED STONE

3.8.1 **Industry Characteristics.** Stone deposits are only found in certain locations in the country. Once a significant deposit is found and a company deems it economically feasible, a quarry operation will be initiated. The site must first be prepared by stripping the top soil. Haul roads will then be built on the site, as well as rail spurs if feasible. If the stone deposit is large enough to be in operation for a few years, a crusher, asphalt plant, or concrete plant may be located at the site. When the material is in usable form, it is transported to the construction site on public roads by trucks. The distance that the trucks usually have to travel from the quarry to the user is 125 miles. Since limestone constitutes 97 percent of the state's crushed stone output, it is the only stone considered herein. Others are sandstone, shell, marl, marble, and traprock. (16)

A major influence on the crushed stone industry is economics for the same reasons as for sand/gravel. A depressed economy causes construction to be down and therefore causes the demand for crushed stone to be down. Also, like the sand and gravel industry, crushed stone has no real peak season, although winter weather causes a slight reduction in this operation.

3.8.2 **Flow Chart/Location Map.** A flow chart which shows the processing of crushed stone from the quarry to the consumer is shown below in Figure 3.8.1. Counties reporting crushed stone production to the U.S. Bureau of Mines in 1981 are shown in Figure 3.8.2. (15)

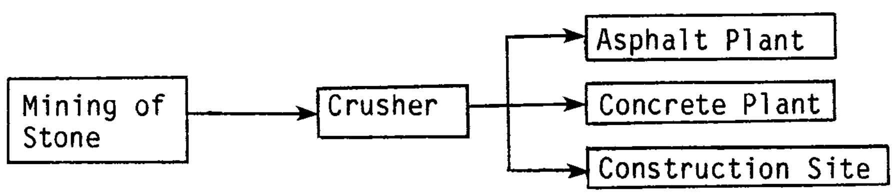


Figure 3.8.1 Stone Flow Chart

3.8.3 **Truck Characteristics.** The stone industry uses the 3-S2 vehicle almost exclusively. The trailer dumps usually by means of a hinged tailgate, with the exception of a few bottom dumps. As in the sand/gravel trailers, the length (according to the bridge formula) is too short to legally gross 80,000 pounds. At least one firm in Texas is using a combination tractor/semi-trailer/trailer with bottom dump to legally gross 80,000 pounds. The other option is to lengthen the 3-S2 rear dump trailer, but the likelihood of overturning is greater while the load is being dumped.

3.8.4 **Vehicular Trips Generated.** The activity center chosen for study was the quarry. As the stone is mined, it is run through a crusher, then segregated by size. The sized material is then either stockpiled or hauled away immediately by truck or rail. A large firm in the state hauled 22 percent of its aggregate by rail last year. This varies somewhat from one quarry to the other but is usually 20 to 30 percent.

A large quarry loads 900 to 1000 truck loads (mostly 3-S2) on an average day. The maximum is about 1,400 loads. Employee work trips are another 800 trip-ends per average day. The legal amount which can be

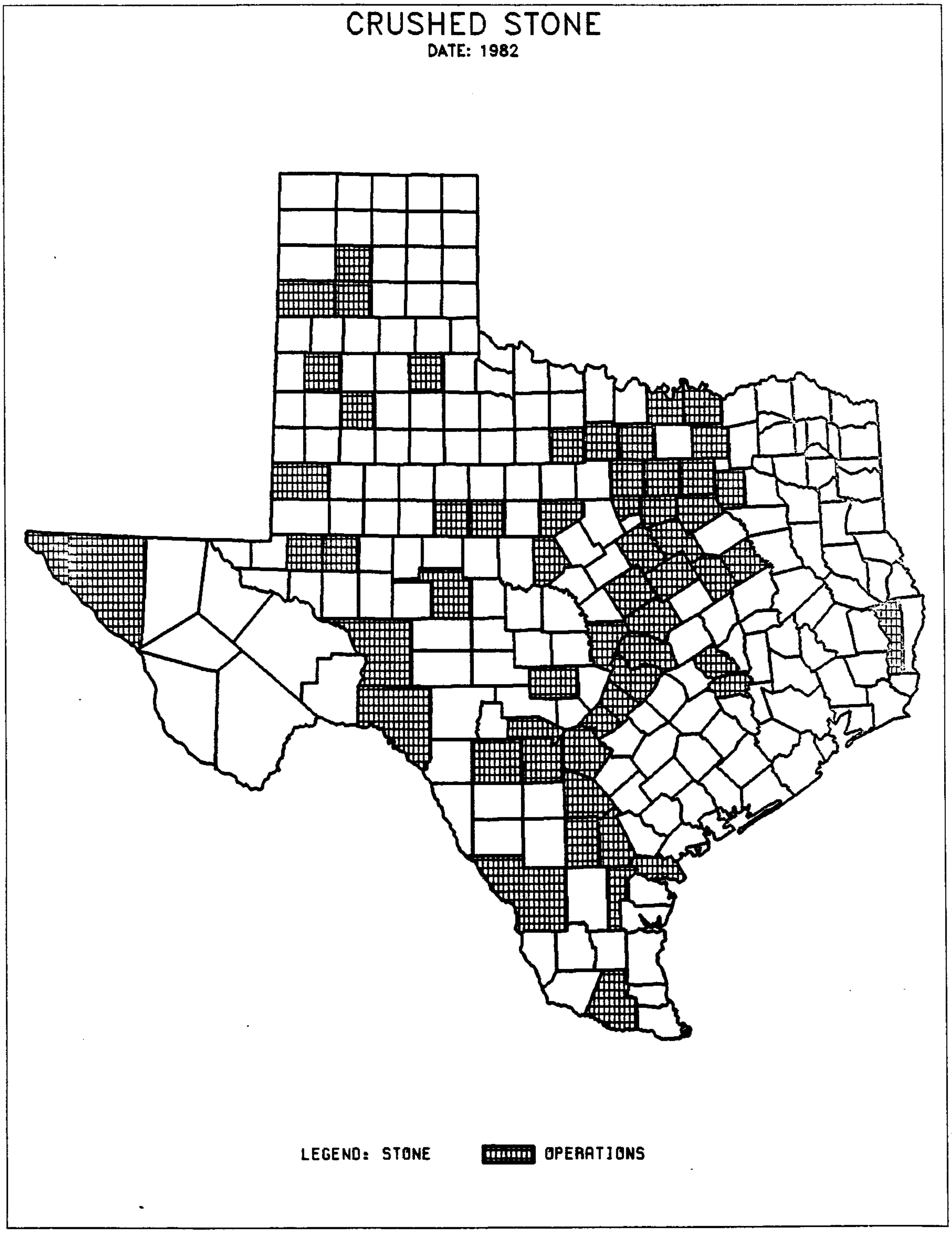


Figure 3.8.2 Location of Crushed Stone Operations, 1981

carried by each truck has been predetermined according to the bridge formula and is not exceeded since the shipper can be fined for "aiding and abetting" if a truck is overweight. The production of this quarry decreases by about 20 percent in the months of January through March.

A slightly larger than average limestone quarry usually produces 450 truckloads per day, with a maximum of 700 loads per day. Its radius of influence extends 125 miles, and the percentage transported by rail is only about 10 percent. The capacity of this operation is 2,000 to 2,200 tons per hour, or about 100 truck loads per hour. Employees add another 300 trip-ends per day.

The statewide production of stone in 1981 was 66,590,614 tons according to the Texas Bureau of Economic Geology. (16)

3.8.5 Trends. The production of crushed stone showed a dramatic increase in 1973-74 from the previous three years. Reductions in 1975-76 and 1981-82 were exceptions to a gradual increase to 1983, as indicated in Figure 3.8.3. (15)

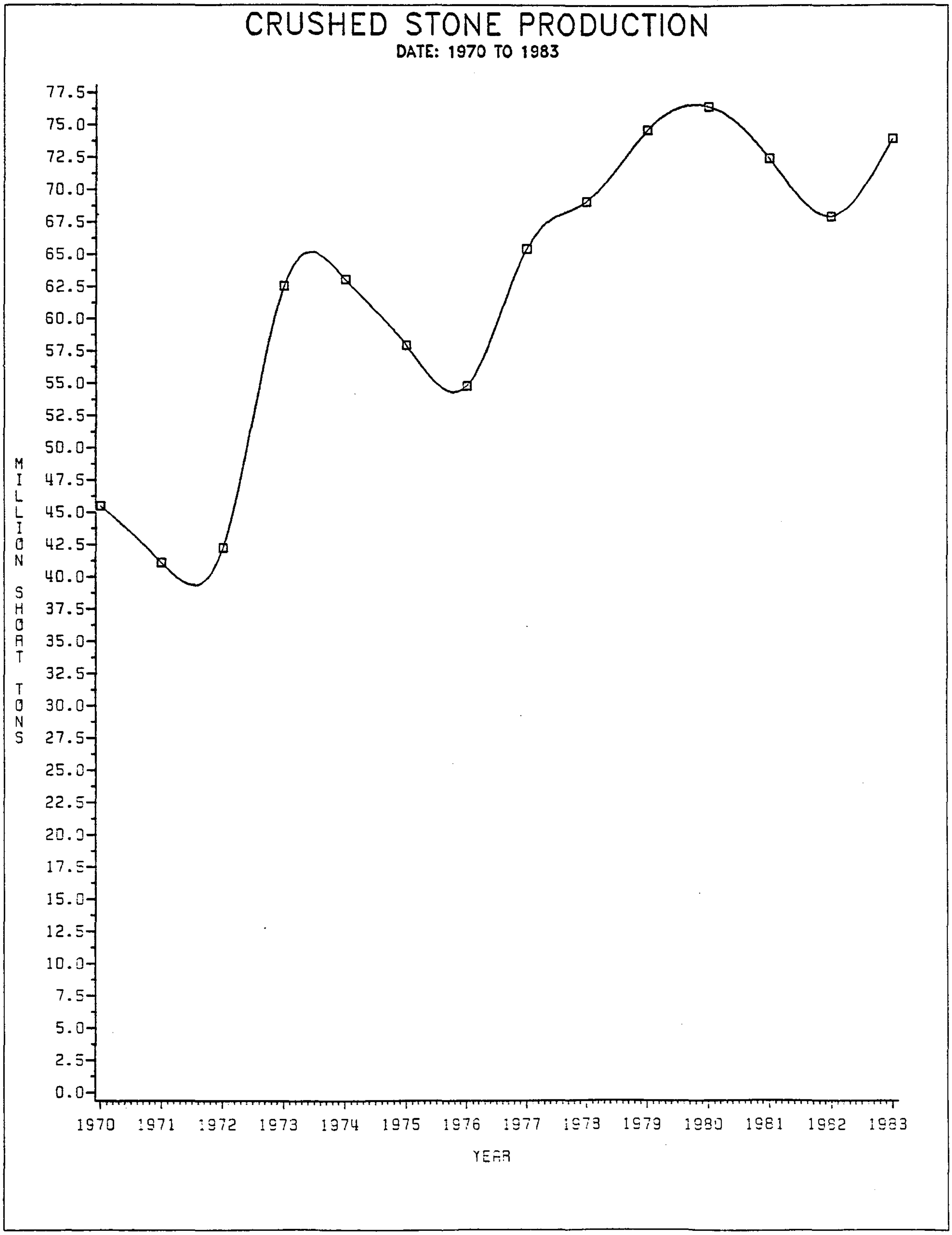


Figure 3.8.3 Trend in Crushed Stone Production

3.9 LIGNITE

3.9.1 Industry Characteristics. Lignite operations in Texas involve very little hauling of the lignite on public roads. In almost all cases it is more economically feasible to build a power plant where the lignite deposit is located rather than haul the lignite to another location. The standard procedure is to build haul roads within the limits of the property permitted for mining by the Railroad Commission of Texas. Any existing public roads which cross this property are normally relocated.

The overall impact of a lignite operation on the surrounding road network must be evaluated as two distinctly different operations. The first, the construction phase, involves the power plant construction and preparation of the mining site for removing the lignite from the earth. The second, the power production phase, begins when the production of electricity begins and involves the simultaneous production of electricity and mining of lignite.

The construction phase involves moving heavy equipment and construction materials into the site and possibly the construction of a railroad spur. In most Texas lignite operations, a huge dragline is used which must be hauled to the site in many pieces and assembled on-site. This process alone takes 1 1/2 to 2 years. Even if a dragline is not used, other heavy equipment such as scrapers and bulldozers must be hauled to the site over existing public roads.

The power production phase begins after construction is complete. Relatively little usage of public roads is then needed for heavy trucks and heavy equipment. However, the daily usage of these roads by employees of the mining operation and the power plant operation must still be considered. The Texas Energy and Natural Resources Advisory Council (TENRAC) reported that in 1982 there were a total of 4,969 employees working at 13 sites in 7 counties in this combined activity of lignite mining and power production. (17) Therefore, the impact on the existing road system surrounding an operation can be determined with some degree of accuracy.

On the other hand, the impact of the construction phase is not well known. It will become increasingly important to investigate the results of this activity as the demand for lignite continues. The construction phase requires public road usage by heavy vehicles, and lasts 2 to 4 years. However, the power production phase continues for 20 to 30 years.

3.9.2 Flow Chart/Location Map. A flow chart which shows the processing of lignite from the mine to the consumer is shown below in Figure 3.9.1.

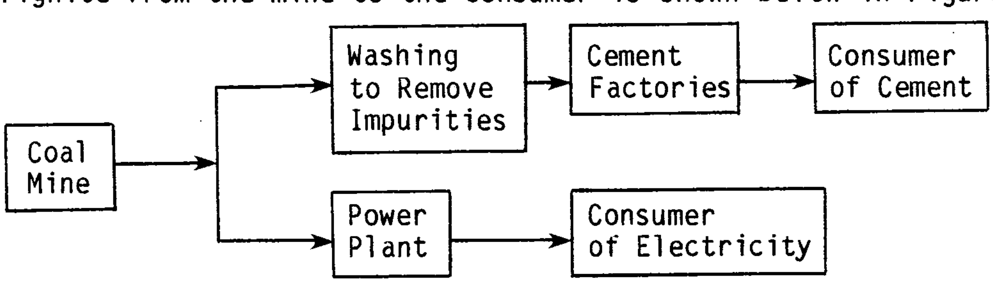


Figure 3.9.1 Lignite Flow Chart

Figure 3.9.2 shows the counties which have permitted and proposed lignite operations as of July 1, 1982. (18) Only three relatively small operations haul lignite by truck on public roads. The mine in Coleman County and the one in Webb County haul the lignite to San Antonio, a distance of over 150 miles. A third mine in Harrison County hauls a distance of approximately 20 miles on public roads.

3.9.3 Truck Characteristics. During the construction phase, many truck types are used to haul construction materials and equipment to the site. These include single-units (concrete mixers), 3-S2 flat-beds, and large oversized/overweight trucks. The distance travelled by these vehicles is highly variable, depending on the location of the nearest city for construction materials, and may be several hundred miles for special equipment. Trucks which haul lignite on public roads during the power production phase are generally 3-S2's similar to those used in sand/gravel and crushed stone operations.

3.9.4 Vehicular Trips Generated. Additional research is necessary to determine specific numbers and types of vehicles generated by this activity during the set-up and construction phase.

During power production or after construction is complete, the typical operation does not haul lignite on public roads. The haul roads are located on the site permitted by the Railroad Commission of Texas for both mining and power plant operations. Only three operations in the state haul on public roads. All of these operations combined only produced 1.7% of the total coal mined in 1983. (18) The two larger facilities mined 260,000 tons of lignite and 376,000 tons of subbituminous coal in 1983. The subbituminous material is a step above lignite in quality and is used primarily in the production of cement. The lignite mine generates about 70 3-S2 loads per day and employs 25 people to work the mine. Other support services include fuel delivery, maintenance, and other supply vehicles. In this case, the lignite is only hauled about 15 miles on public roads.

A second subbituminous operation which hauls the material on public roads is even smaller than the first at a 1983 production level of about 50,000 tons. About 7 to 8 3-S2 loads per day are hauled a distance of about 180 miles. Employees add another 20 trips per day, while service vehicles add about one trip per day.

3.9.5 Trends. Figure 3.9.3 indicates the total statewide production of coal from 1970 through 1982. Bituminous coal accounted for less than 2 percent of the coal produced in 1979, 1980, and 1981, with lignite accounting for the major percentage. This plot shows the constant and quite rapid increase in statewide production. This growth is also indicated by the fact that Texas moved from 18th in national ranking for coal production in 1970 to 9th in 1980 and 1981. Texas is presently number one in lignite production. (18)

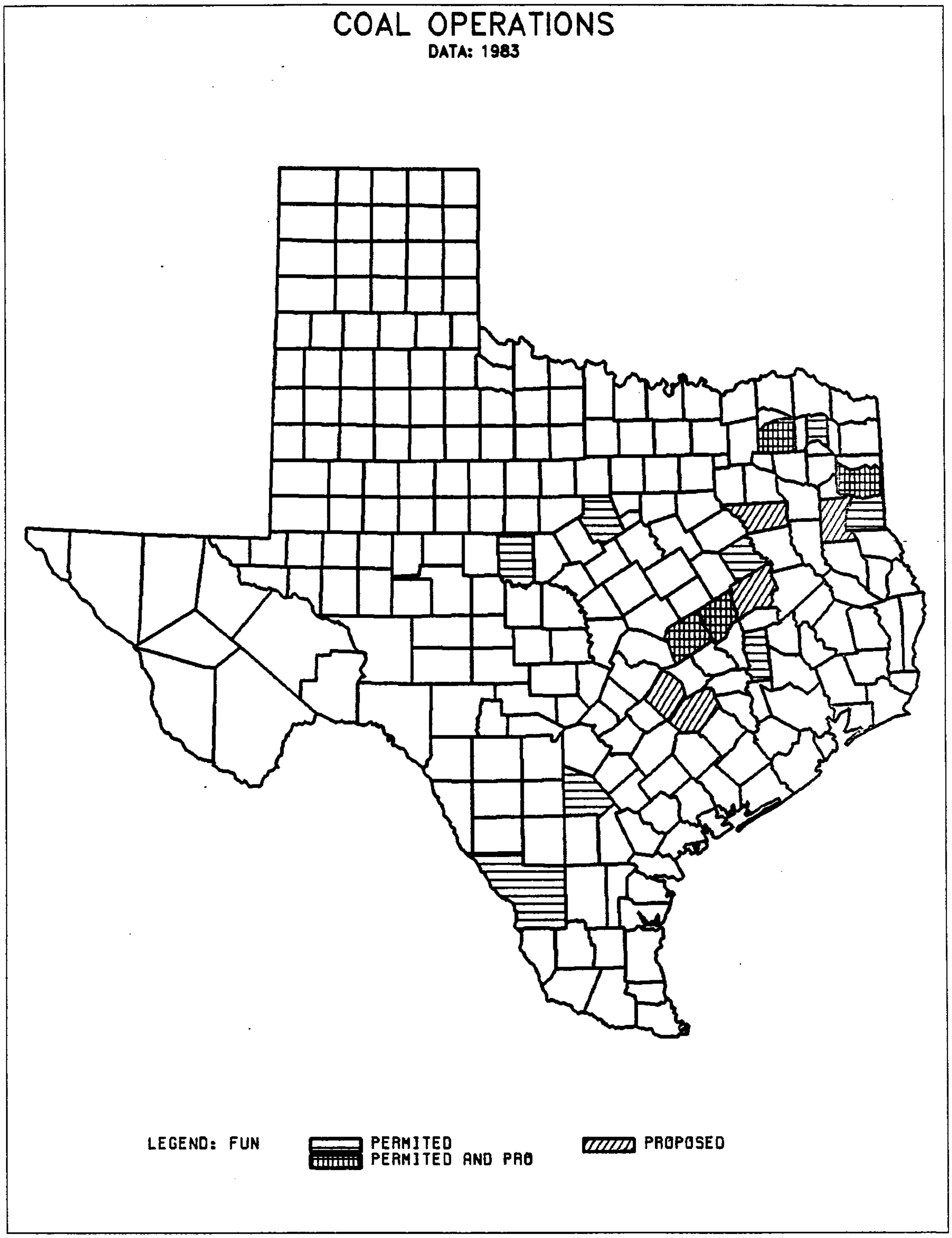


Figure 3.9.2 Location of Permitted and Proposed Lignite Operations

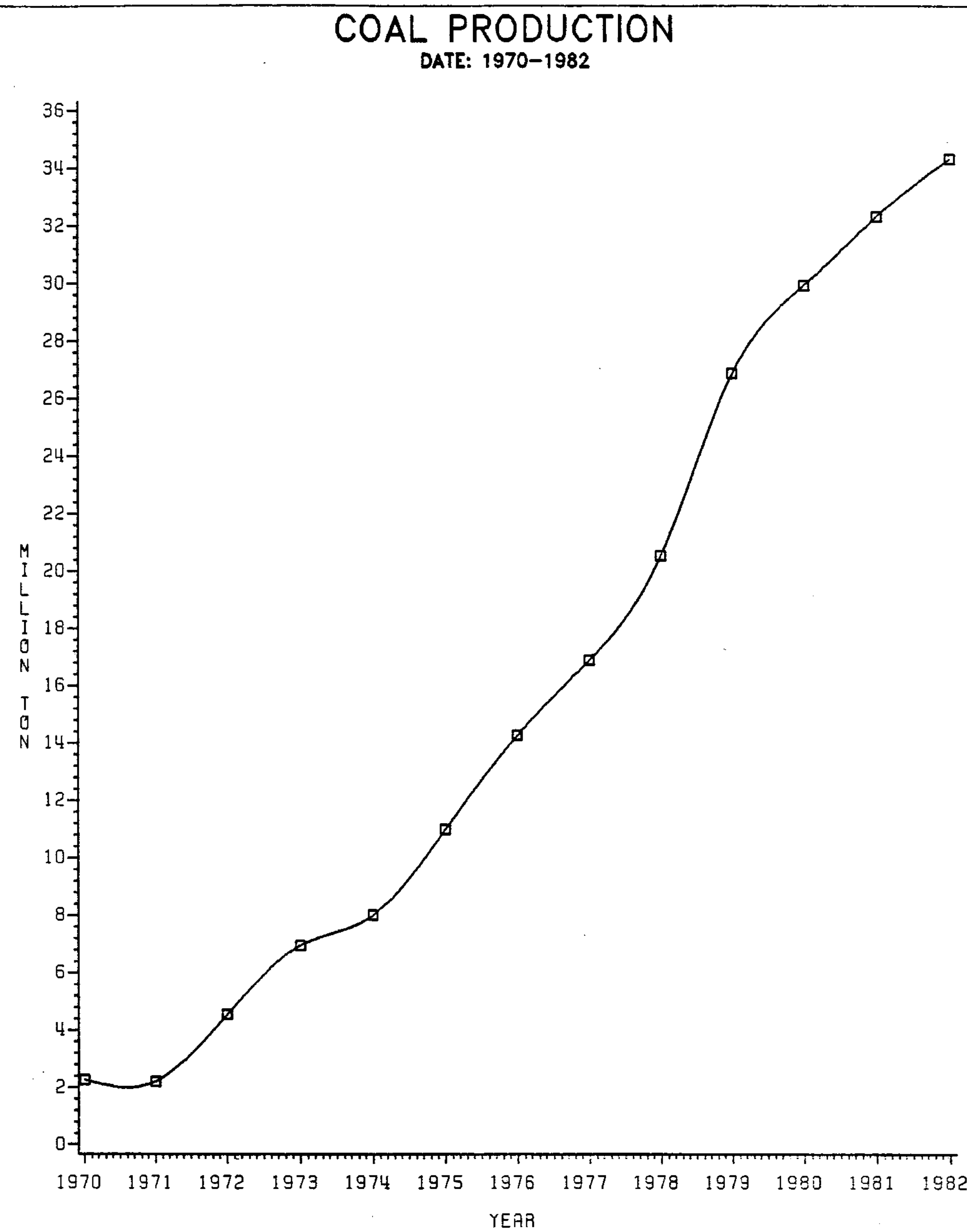


Figure 3.9.3 Trend in Coal Production

3.10 URANIUM

3.10.1 Industry Characteristics. Uranium ore from the mine is loaded onto trucks and usually hauled on public roads to a mill site stockpile. One ton of uranium ore yields only 2 pounds of uranium oxide (U_3O_8). At the mill site the ore is first sampled and tested, then treated in several individual processes to separate the pure uranium concentrate. This concentrate, called yellowcake is packed in steel drums and is purchased by large electric utilities who pay others to have it enriched and treated. It is eventually manufactured into fuel elements which are used at power generating plants to produce electricity.

Recently, the demand and, therefore, the price of uranium ore has seen a dramatic decrease. The price in 1979 was $43 per pound; in 1982 it had fallen to $20.50 per pound. (18) The cost involved in extracting and milling the ore, along with reclamation activities following mining, are greater than the reduced price of the uranium oxide.

3.10.2 Flow Chart/Location Map. A flow chart which shows the processing of uranium oxide from the mine to the electric companies is shown in Figure 3.10.1. The only uranium mining operation still underway in the State involves two individual sites near Panna Maria in Karnes County. One site is 20 miles from the mill and the other is at the mill (Source: Railroad Commission of Texas). Other counties adjacent to Karnes County which previously had mining operations are: Gonzales County, Atascosa County, Live Oak County, and McMullen County. The location of the current activity is shown by Figure 3.10.2.

Figure 3.10.1 Uranium Flow Chart

3.10.3 Truck Characteristics. Trucks used to haul uranium oxide on public roads are similar to those used in other surface mining operations such as sand/gravel and crushed stone. The 3-S2 is the most common vehicle used with a few single-unit, three axle trucks as well. Trip lengths are usually relatively short, in the range of 20-50 miles.

The uranium after treatment (called yellowcake) is hauled in steel drums by 3-S2's to another location where it is treated and enriched.

3.10.4 Vehicular Trips Generated. Since the mining of uranium has fallen so drastically in the past few years, its current level does not pose nearly as significant a problem for maintaining public roads as before. No information was gathered for trips generated by this industry.

3.10.5 Trends. Figure 3.10.3 is a plot of uranium oxide produced from 1976 through 1984. The decline in demand and production began in 1980-81. Texas was the third largest producer of uranium oxide in the United States in 1981. (18)

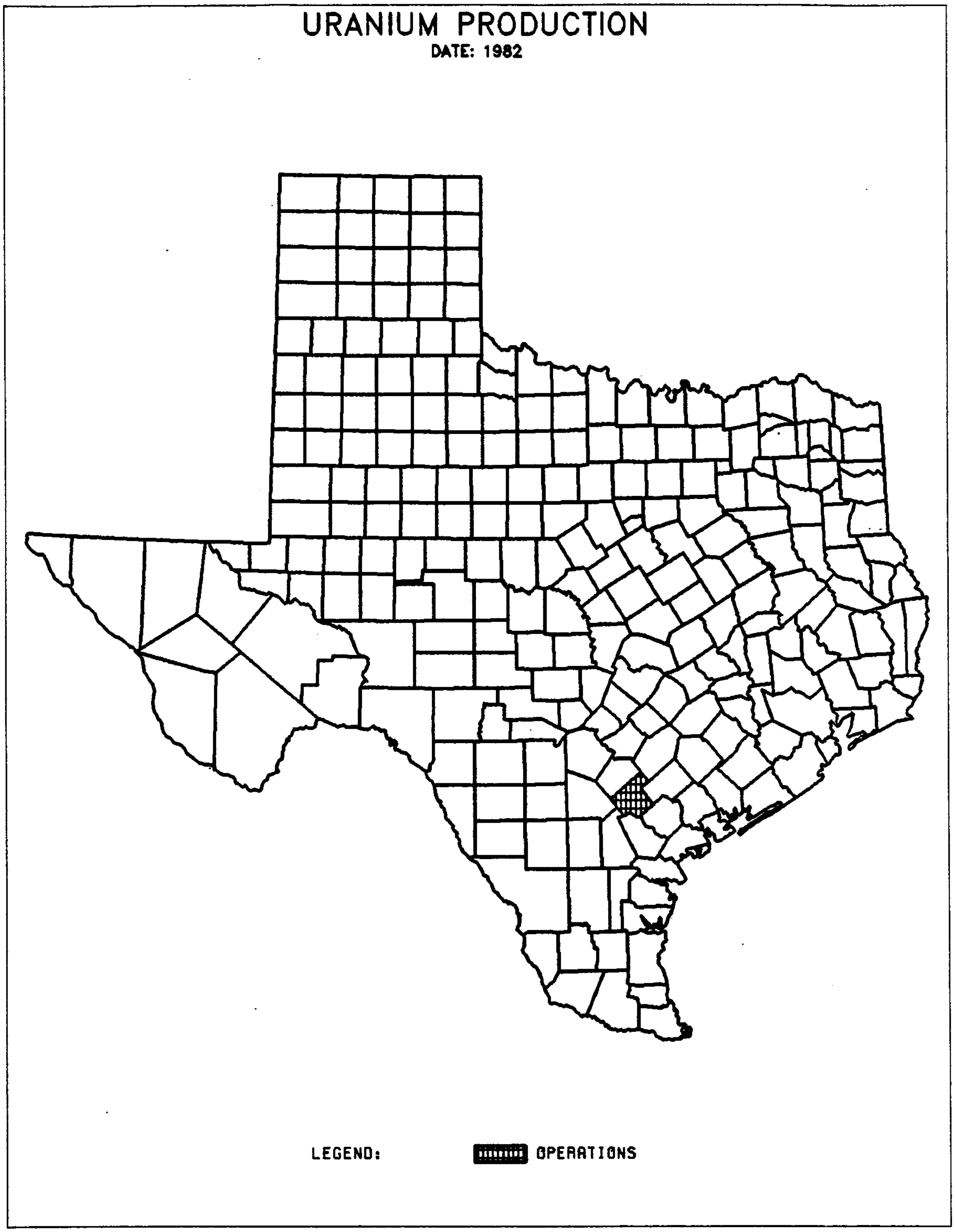


Figure 3.10.2 Location of Uranium Mining

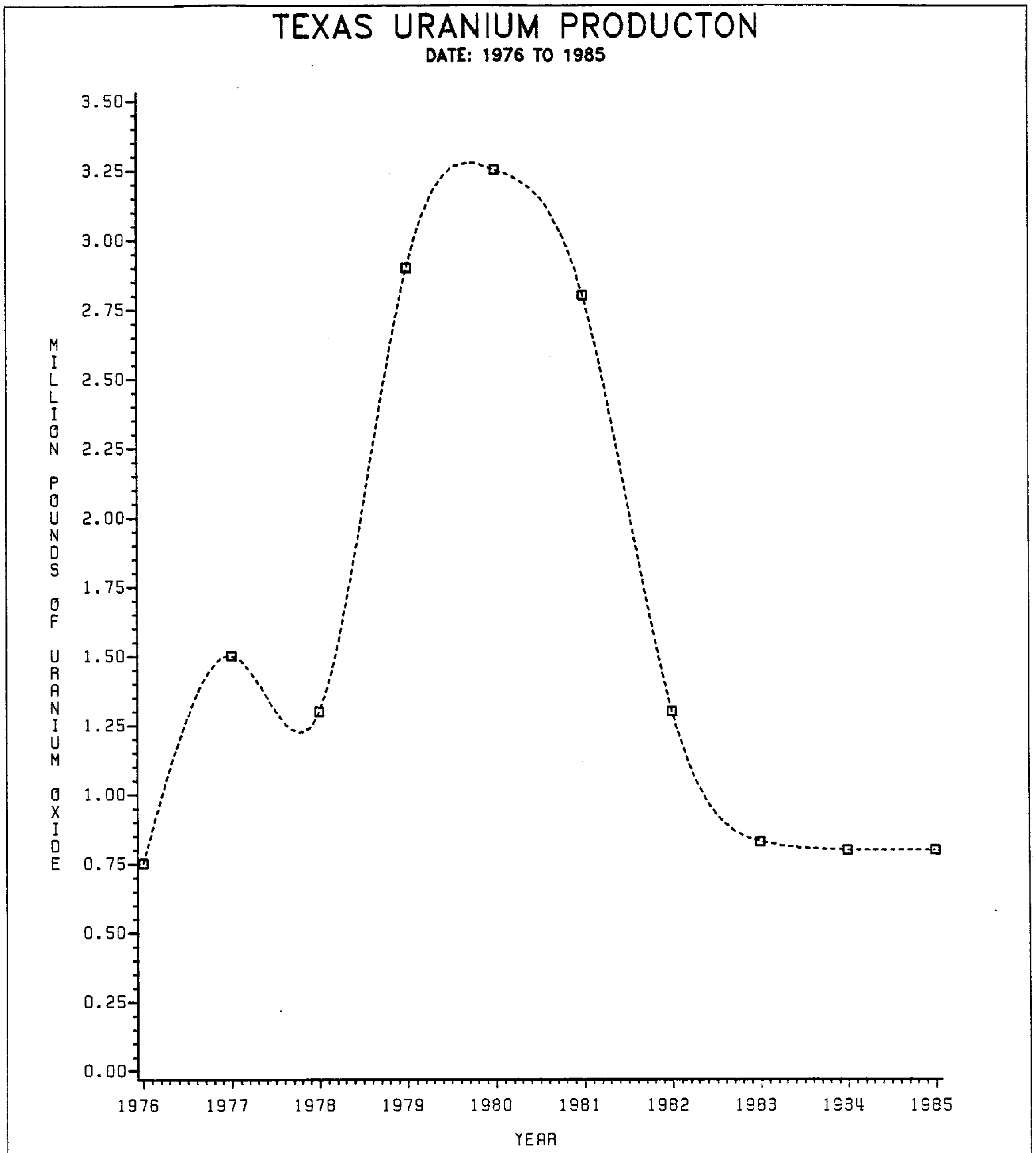


Figure 3.10.3 Trend in Uranium Production

3.11 IRON ORE

3.11.1 Industry Characteristics. Iron ore is mined in northeast Texas and is used for road base material in the surrounding counties and for iron and steel production if the quality of ore is good enough. One large steel mill in northeast Texas is making steel pipe for oil drilling and is now hiring others to haul the ore rather than hauling its own ore. This ore is hauled on private roads and only crosses public roads occasionally. Trucks hauling the finished products away from the mill use public roads.

The hauling of iron ore gravel for road base material usually occurs on public roads--both county and state roads. There is at least one fairly large contractor who mines and hauls the material, but many small contractors haul this material for road construction and maintenance or for oil well drilling pads.

The resource is found at the top of hills in northeast Texas in variable qualities. Most of the ore is not suitable for steel production but has a relatively high specific gravity and works well in road construction. The ore is usually found in seams to depths of 3 to 4 feet, and up to 20 to 25 feet in some locations. The area covered by a single deposit may be as small as 2 to 3 acres or as large as 30 acres. (Source: Railroad Commission of Texas).

It should be noted that specific information on the mining of iron ore is difficult to acquire since the Railroad Commission of Texas did not begin regulating the industry until September, 1983. It was also difficult to secure information from specific industries. Even visual determination along the haul roads is difficult since a red clay is also hauled which looks identical to iron ore from a distance. Therefore, traffic classification counts in addition to site visits should be planned for the future, if further knowledge of this commodity movement is desirable.

3.11.2 Flow Chart/Location Map. A flow chart which shows the processing of iron ore from the mining area to consumer is shown below in Figure 3.11.1. The region where this ore is found is northeast Texas. Siderite and limonite deposits in the "North Basin" are found in Camp, Cass, Marion, and parts of Upshur and Harrison Counties, in the upper half of a major geologic unit known as the Weches Formation. Limonite deposits in the so-called "South Basin" are found in Gregg, Henderson, Rusk, Smith, Van Zandt, and parts of Anderson, Cherokee, Harrison, Nacogdoches, Upshur, and Wood Counties in the top of the Weches Formation (19). Figure 3.11.2 indicates the specific counties which contain these deposits.

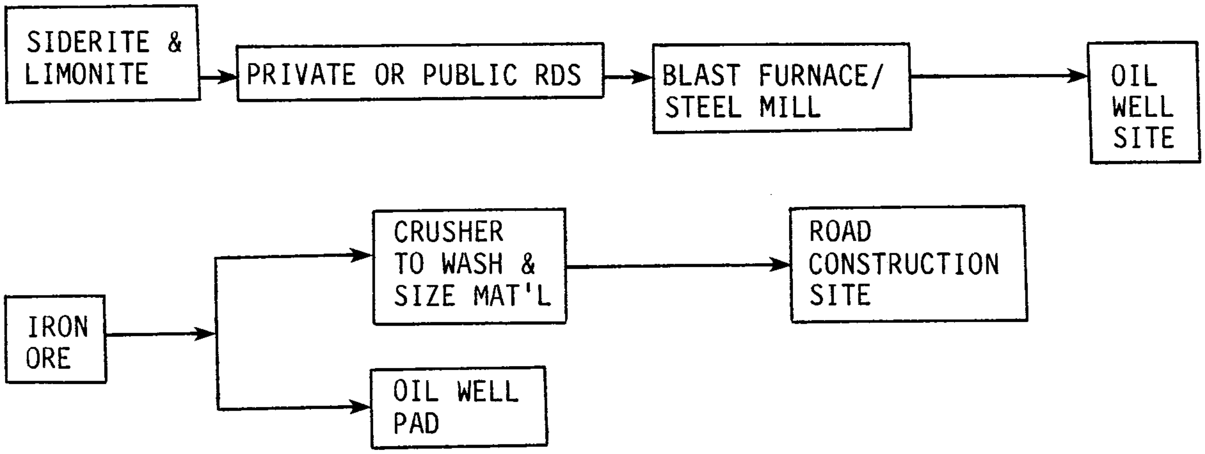


Figure 3.11.1 Iron Ore Flow Chart

3.11.3 Truck Characteristics. Trucks typically used by smaller contractors to haul iron ore gravel for road construction are three-axle, single unit trucks (SU-2). The larger contractors use more 3-S2's but still use the SU-2 vehicles. Trucks which haul steel pipe away from the steel mill are almost exclusively 3-S2.

3.11.4 Vehicular Trips Generated. No information is known at this time concerning the trip generation characteristics at the mining area or the steel mill.

3.11.5 Trends. No public records were kept of total iron ore production on a statewide basis until September, 1983.

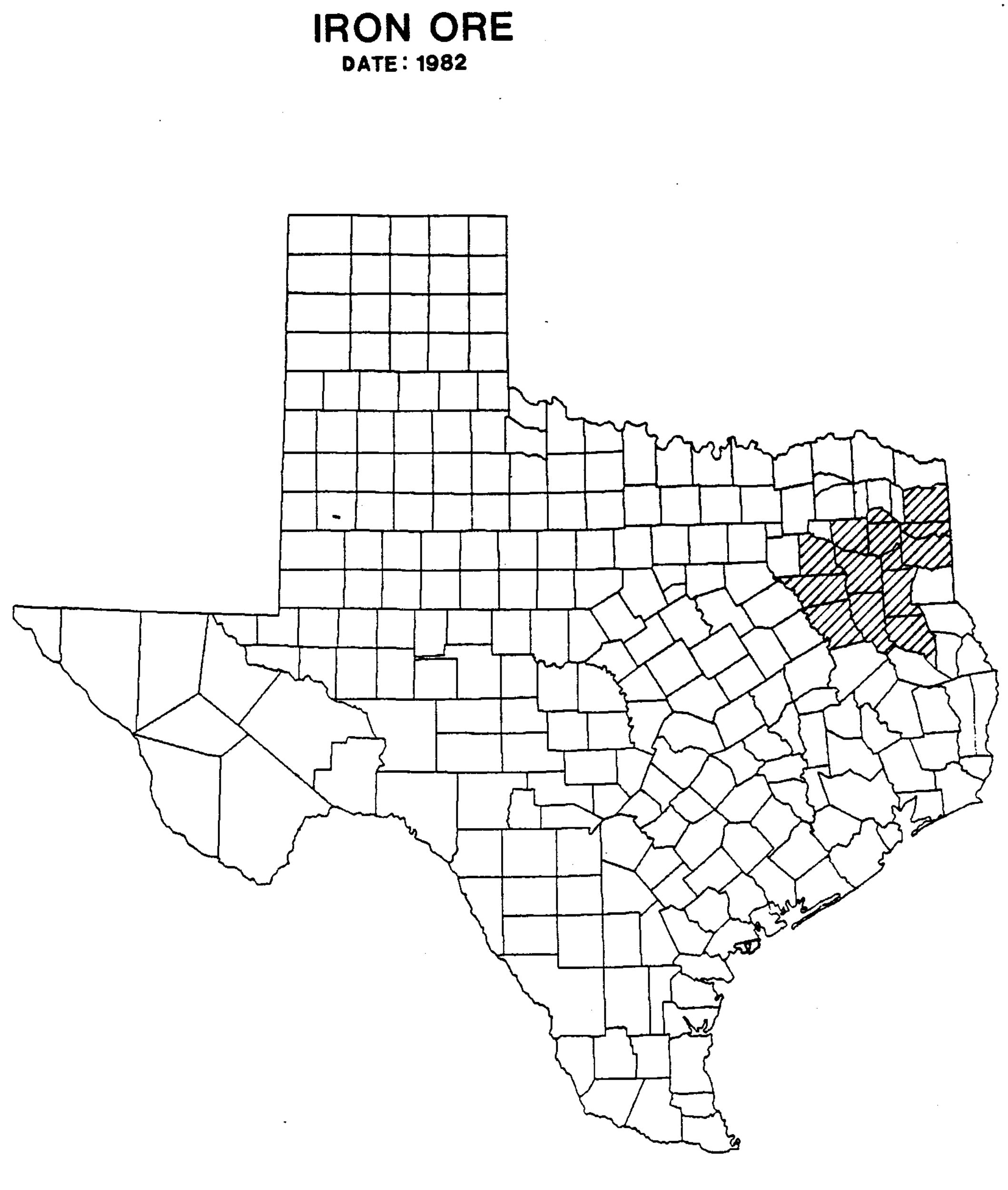


Figure 3.11.2 Location of Iron Ore

4.0 IMPLEMENTATION OF FINDINGS

4.1 COMPARATIVE TRENDS AND STATE DENSITY MAP

4.1.1 **Comparative Trends.** Figure 4.1.1 portrays the relative magnitudes of the statewide totals by year for each commodity except iron ore, lignite, and uranium. The reasons for excluding these three commodities are as follows: first, insufficient information was available to include these three commodities in this analysis. Additionally, the hauling of lignite by truck is usually not a problem on public roads after start-up of the power production phase since private roads are almost always used to haul the lignite from the mine to the power plant. Iron ore was not regulated until September, 1983, so no records are available to determine statewide production. Uranium is currently being mined at a very low rate in only one county and is not expected to increase in the foreseeable future.

4.1.2 **State Density Map.** Figure 4.1.2 shows the number of special-use commodities found in each county if they occur in amounts greater than one million pounds. The specific commodities found in each county in this same amount are given in Table 4.1.1. The overlapping impacts of all commodities found within each county must be considered in order to arrive at the total impact. Approximately ten counties have none of the special-use commodities in the minimum amount specified, while the remainder have one or more. The maximum number of commodities found in any one county was seven of the possible eleven.

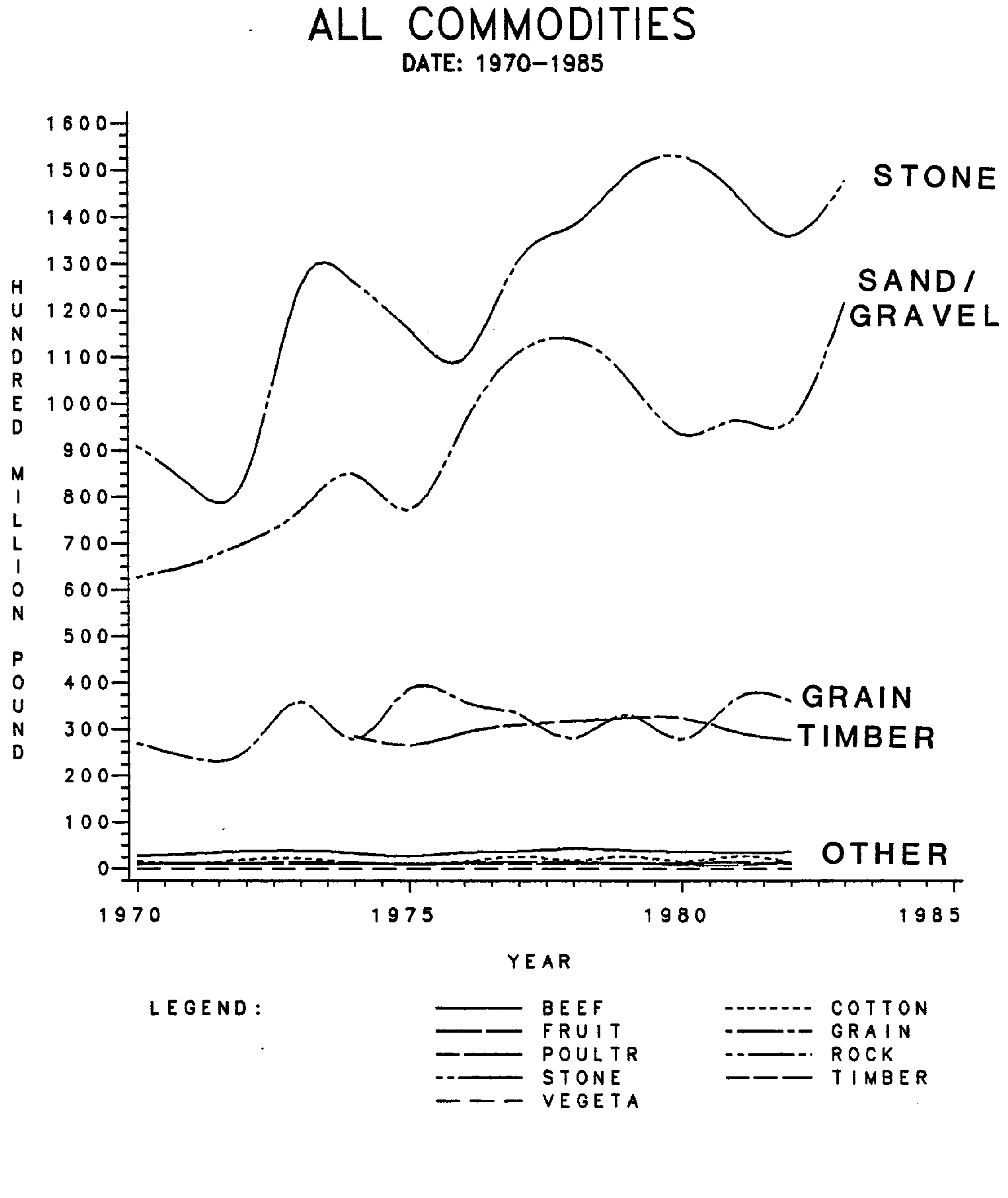


Figure 4.1.1 Composite Commodity Trends

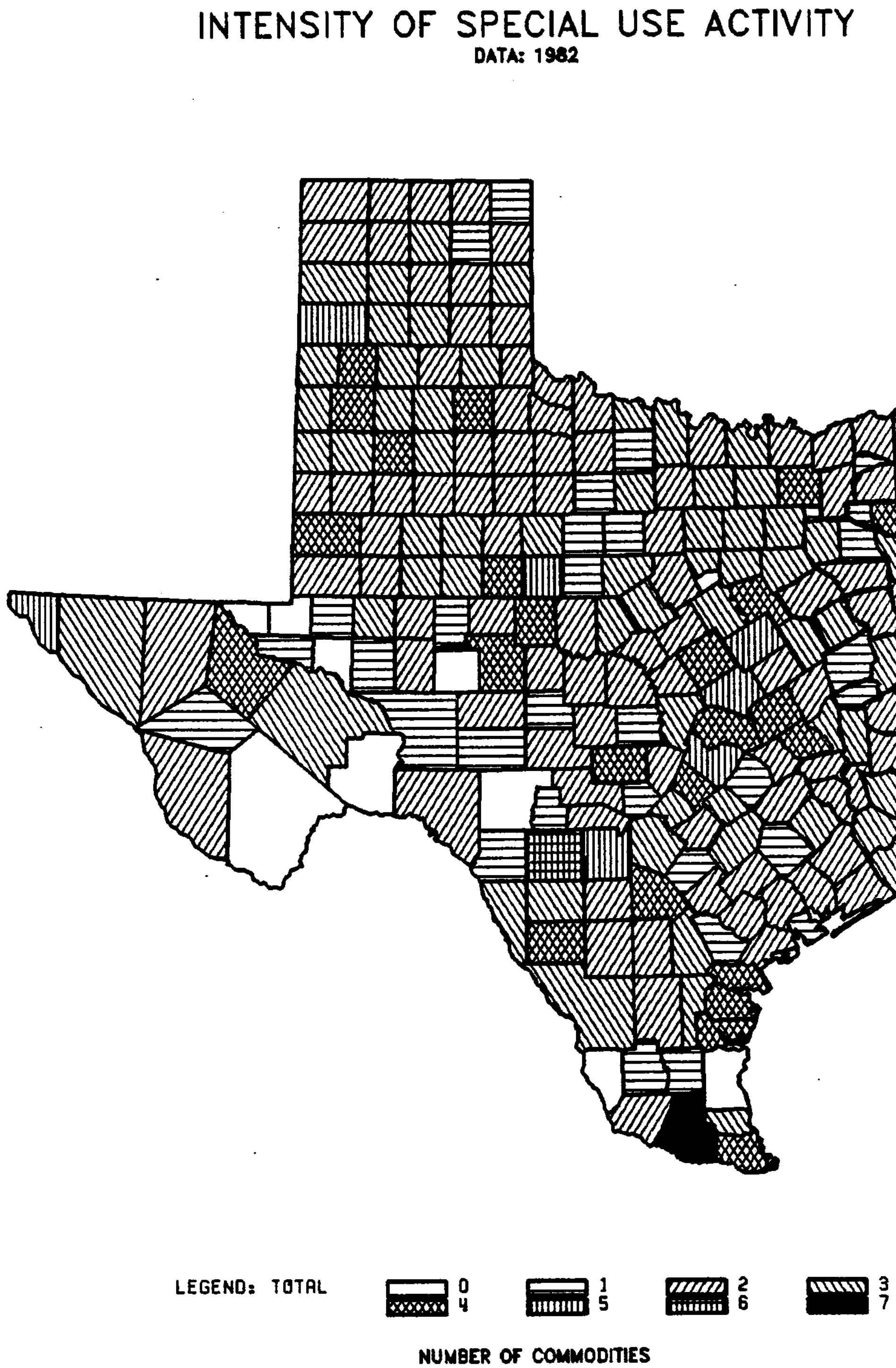


Figure 4.1.2 Special-Use Commodity Overlap

Table 4.1.1 County/Commodity Matrix

NAME	BEEF CATTLE	POULTRY	COTTON	GRAIN	FRUIT	VEGETABLES	COAL	TIMBER	SAND	STONE	URANIUM	TOTAL
ANDERSON				X				X				2
ANDREWS			X	X								2
ANGELINA								X				1
ARANSAS				X								1
ARCHER				X								1
ARMSTRONG	X			X					X			3
ATASCOSA				X			X		X	X		4
AUSTIN	X			X								2
BAILEY	X		X	X								3
BANDERA				X						X		2
BASTROP				X								1
BAYOR			X	X								2
BEE				X								1
BELL		X	X	X					X	X		5
BEXAR				X					X	X		3
BLANCO		X		X								2
BORDEN			X	X					X			3
BOSQUE		X		X						X		3
BOWIE	X	X		X				X	X			5
BRAZORIA			X	X					X			3
BRAZOS			X	X					X			3
BREWSTER												0
BRISCOE			X	X								2
BROOKS				X								1
BROWN		X		X						X		3
BURLESON			X	X					X	X		4
BURNET				X					X	X		3
CALDWELL		X	X	X								3
CALHOUN				X								1
CALLAHAN				X								1
CAMERON	X		X	X	X							4
CAMP		X						X				2
CARSON	X			X								2
CASS		X						X				2
CASTRO	X		X	X		X						4
CHAMBERS				X				X	X			3
CHEROKEE				X				X				2
CHILDRESS			X	X								2
CLAY	X		X	X								3
COCHRAN	X		X	X								3
COKE				X					X			2
COLEMAN		X		X								2
COLLIN	X		X	X						X		4
COLLINGSWORTH			X	X								2
COLORADO	X			X					X			3
COMAL				X					X	X		3
COMANCHE	X	X		X								3
CONCHO			X	X								2
COOKE				X					X	X		3
CORYELL		X		X					X	X		4
COTTLE			X	X								2
CRANE												0
CROCKETT										X		1
CROSBY			X	X					X			3
CULBERSON			X	X								2
DALLAM	X			X								2

Table 4.1.1 County/Commodity Matrix (Continued)

NAME	BEEF CATTLE	POULTRY	COTTON	GRAIN	FRUIT	VEGETABLES	COAL	TIMBER	SAND	STONE	URANIUM	TOTAL
DALLAS				X					X	X		3
DAWSON			X	X								2
DEAF SMITH	X		X	X		X				X		5
DELTA				X								1
DENTON			X	X					X			3
DE WITT		X		X								2
DICKENS			X	X								2
DIMMIT	X		X	X	X							4
DONLEY			X	X								2
DUVAL				X					X			2
EASTLAND		X		X						X		3
ECTOR										X		1
EDWARDS												0
ELLIS			X	X						X		3
EL PASO	X		X	X					X	X		5
ERATH		X		X								2
FALLS			X	X								2
FANNIN				X					X			2
FAYETTE				X					X			2
FISHER			X	X								2
FLOYD	X		X	X								3
FOARD			X	X								2
FORT BEND		X	X	X								3
FRANKLIN		X		X				X				3
FREESTONE				X			X			X		3
FRIO	X			X								2
GAINES	X		X	X						X		4
GALVESTON				X					X			2
GARZA			X	X								2
GILLESPIE		X		X					X	X		4
GLASSCOCK			X	X								2
GOLIAD	X			X								2
GONZALES	X	X		X								3
GRAY	X			X								2
GRAYSON				X						X		2
GREGG								X	X			2
GRIMES				X			X	X				3
GUADALUPE				X					X			2
HALE	X		X	X								3
HALL			X	X					X			3
HANILTON		X		X								2
HANSFORD	X			X								2
HARDEMAN			X	X								2
HARDIN				X				X	X			3
HARRIS				X				X	X			3
HARRISON		X					X	X	X			4
HARTLEY	X			X								2
HASKELL			X	X								2
HAYS	X			X					X	X		4
HEMPHILL	X			X								2
HENDERSON				X					X			2
HIDALGO	X		X	X	X	X			X	X		7
HILL		X	X	X						X		4
HOCKLEY	X		X	X								3
HOOD	X			X						X		3
HOPKINS				X			X					2

Table 4.1.1 County/Commodity Matrix (Continued)

NAME	BEEF CATTLE	POULTRY	COTTON	GRAIN	FRUIT	VEGETABLES	COAL	TIMBER	SAND	STONE	URANIUM	TOTAL
HOUSTON			X	X				X				3
HOWARD			X	X					X			3
HUDSPETH			X	X						X		3
HUNT			X	X								2
HUTCHINSON	X			X					X			3
IRION												0
JACK				X						X		2
JACKSON			X	X								2
JASPER								X		X		2
JEFF DAVIS				X								1
JEFFERSON				X				X				2
JIM HOGG				X								1
JIM WELLS			X	X						X		3
JOHNSON				X					X	X		3
JONES	X		X	X								3
KARNES				X							X	2
KAUFMAN			X	X						X		3
KENDALL				X								1
KENEDY												0
KENT			X	X								2
KERR				X					X			2
KIMBLE				X					X			2
KING			X	X								2
KINNEY				X								1
KLEBURG	X	X	X	X								4
KNOX			X	X								2
LAMAR		X		X								2
LAMB	X		X	X						X		4
LAMPASAS				X					X			2
LA SALLE	X			X								2
LAVACA				X								1
LEE		X		X								2
LEON								X				1
LIBERTY				X				X	X			3
LIMESTONE				X					X	X		3
LIPSCOMB				X								1
LIVE OAK				X					X	X		3
LLAND		X										1
LOVING												0
LUBBOCK	X		X	X						X		4
LYNN			X	X								2
MC CULLOCH				X					X			2
MC LENNAN		X	X	X					X	X		5
MC MULLEN				X						X		2
MADISON				X								1
MARTIN								X				1
			X	X								2
MASON	X	X										2
MATAGORDA			X	X								2
MAVERICK	X			X					X			3
MEDINA	X		X	X					X	X		5
MENARD				X								1
MIDLAND			X	X						X		3
MILAM		X	X	X			X					4
MILLS		X		X								2
MITCHELL			X	X					X			3

Table 4.1.1 County/Commodity Matrix (Continued)

NAME	BEEF CATTLE	POULTRY	COTTON	GRAIN	FRUIT	VEGETABLES	COAL	TIMBER	SAND	STONE	URANIUM	TOTAL
MONTAGUE	X			X								2
MONTGOMERY								X	X			2
MOORE	X			X								2
MORRIS		X		X				X				3
MOTLEY			X	X					X	X		4
NACOGDOCHES		X						X				2
NAVARRO			X	X								2
NEWTON								X	X			2
NOLAN	X		X	X					X			4
NOLAN	X		X	X					X	X		5
NUECES		X	X	X					X			4
OCHILTREE	X			X								2
OLDHAM	X			X					X			3
ORANGE				X				X	X			3
PALO PINTO				X					X			2
PANOLA		X		X			X	X				4
PARKER				X					X	X		3
PARMER	X		X	X								3
PECOS	X		X	X								3
POLK								X	X			2
POTTER				X					X	X		3
PRESIDIO	X			X								2
RAINS				X								1
RANDALL	X			X						X		3
REAGAN			X	X								2
REAL				X								1
RED RIVER		X		X				X				3
REEVES	X		X	X					X			4
REFUGIO			X	X								2
ROBERTS				X								1
ROBERTSON			X	X								2
ROCKWALL				X								1
RUNNELS	X		X	X					X			4
RUSK								X				1
SABINE		X						X				2
SAN AUGUSTINE		X						X				2
SAN JACINTO								X				1
SAN PATRICIO	X		X	X						X		4
SAN SABA		X		X								2
SCHLEICHER			X	X								2
SCURRY	X		X	X								3
SHACKELFORD				X								1
SHELBY		X		X				X				3
SHERMAN	X			X								2
SMITH				X				X	X			3
SOMERVELL												0
STARR				X		X						2
STEPHENS				X								1
STERLING				X								1
STONEWALL			X	X								2
SUTTON				X								1
SWISHER	X		X	X								3
TARRANT				X					X	X		3
TAYLOR	X		X	X					X	X		5
TERRELL												0
TERRY			X	X								2

Table 4.1.1 County/Commodity Matrix (Continued)

NAME	BEEF CATTLE	POULTRY	COTTON	GRAIN	FRUIT	VEGETABLES	COAL	TIMBER	SAND	STONE	URANIUM	TOTAL
THROCKMORTON				X								1
TITUS		X		X			X	X				4
TOM GREEN	X		X	X						X		4
TRAVIS		X	X	X					X	X		5
TRINITY								X				1
TYLER				X				X				2
UPSHUR		X						X	X			3
UPTON			X									1
UVALDE	X		X	X		X			X	X		6
VAL VERDE									X	X		2
VAN ZANDT				X								1
VICTORIA				X					X			2
WALKER				X				X				2
WALLER				X				X				2
WARD									X			1
WASHINGTON				X						X		2
WEBB				X					X	X		3
WHARTON			X	X								2
WHEELER	X		X	X								3
WICHITA			X	X					X			3
WILBARGER			X	X								2
WILLACY			X	X	X							3
WILLIAMSON			X	X					X	X		4
WILSON				X								1
WINKLER												0
WISE				X					X	X		3
WOOD		X		X				X	X			4
YOAKUM			X	X								2
YOUNG				X					X	X		3
ZAPATA												0
ZAVALA	X		X	X								3

4.2 PAVEMENT MANAGEMENT

The truck traffic generated by the previously identified special-use activities causes a certain predictable amount of damage, given the specific pavement design, subgrade characteristics, and the number of axle load repetitions. A procedure was developed to predict pavement damage due to oil field activity in an earlier research effort described in Research Report 299-2. Project 420 modified this "Oil Field Damage Program" to also predict the impact of other special-use activities. Both intended-use and special-use traffic distributions are converted into 18-kip equivalent single-axle load repetitions (18-k ESAL) and placed upon a pavement of known structural capability to evaluate the pavement's performance under the prescribed circumstances.

4.2.1 Computer Program. A copy of the computer program used to determine the damage caused by the specific timber activity evaluated in the case study is included in the Appendix. The cutting site involved a higher rate of cutting activity than would typically be found. The specific distribution of traffic and vehicle weights at this cutting site were approximated by loadometer data from Station #505 located in Nacogdoches, Texas. The results of the case study reflect the assumptions of axle load estimates.

It is suspected that the weights obtained at the loadometer station are significantly less than the actual weights which would have been found near this cutting site. Therefore, the pavement damage program should be executed using more accurate weight and vehicle classification data. Future phases of this study will allow for collection of the much needed additional data. If the additional weight data are significantly heavier as suspected, then the impact on pavement life will be substantially worse.

4.2.2 Case Study. This case study demonstrates the utility of trip generation data to the Department, even though the rate of timber cutting is higher than usual. A cutting site in the Sam Houston National Forest was chosen for evaluation as indicated by Figure 4.2.1. Access to the cutting site was via two Farm-to-Market roads, FM 2296 and FM 1375 which were used equally by timber trucks hauling from the site to the mill. These roads are 20- to 22-foot surface-treated roadways with a 9-inch base and seal coat. FM 1375 was chosen as the road to be evaluated. Before the timber contractor began cutting, the ADT for FM 1375 was 1,000 vehicles with 11 percent trucks and a predicted growth rate of 5 percent per year.

Timber was harvested for seven months with approximately 400 acres of timber being clear-cut per month. This resulted in 35 to 40 truck loads leaving the cutting site per work day. The subject timber traffic began using the road 17 months after FM 1375 had major resurfacing work done.

This information was used as input into the aforementioned pavement damage program (1) to predict the decrease in serviceability due to this specific timber traffic. The program results indicate that the road under intended use traffic should require resurfacing after approximately 37 months. This appears reasonable since resurfacing work was being done approximately every 3 years on the road under intended use or baseline traffic. The results of the program indicated that the additional traffic

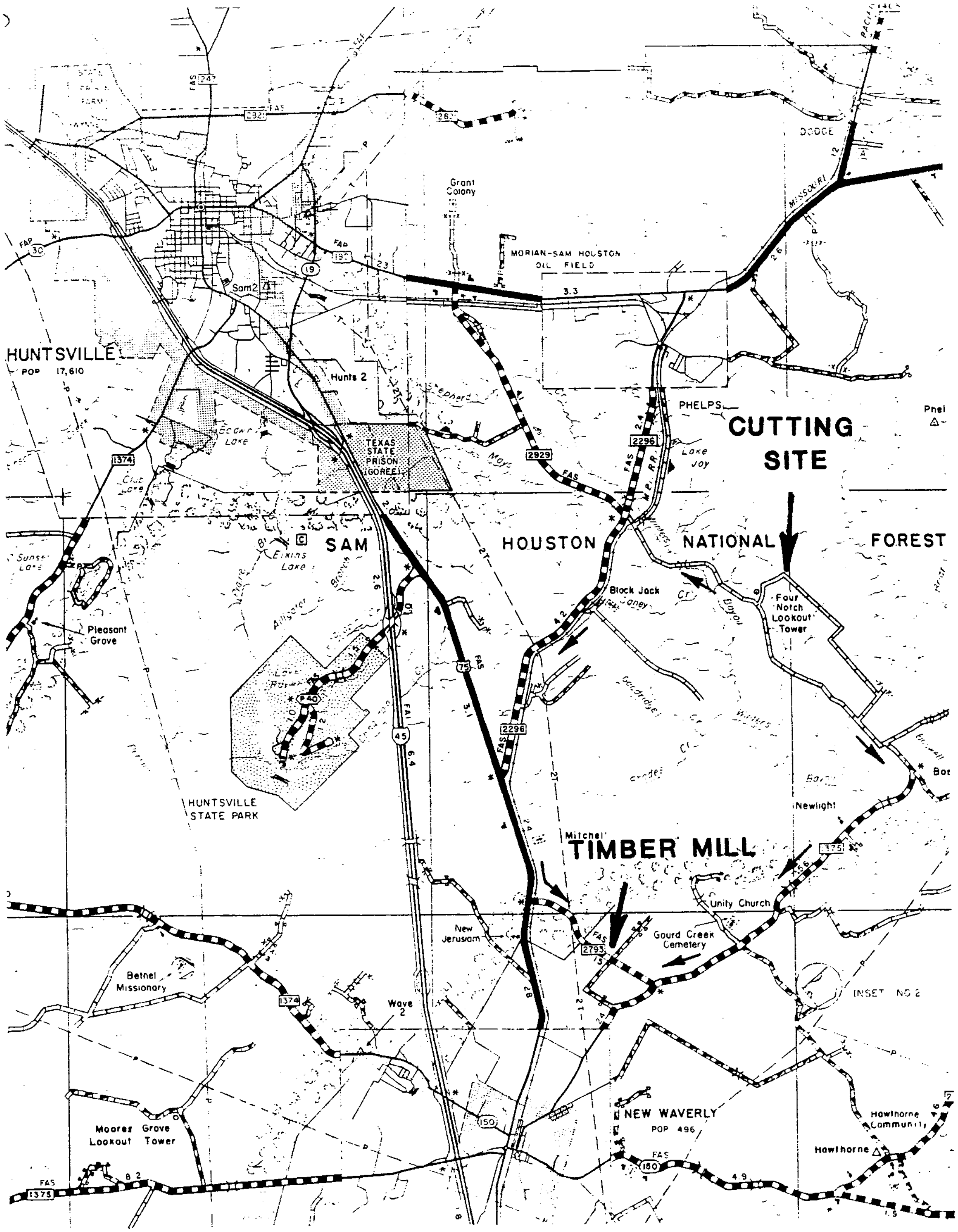


Figure 4.2.1 Case Study Location Map

demand required resurfacing approximately 6 months earlier than would be necessary under the baseline growth in traffic. This is indicated graphically in Figure 4.2.2 by the difference in time (months) before the predicted pavement score is reduced to 35.

In reality, some roads of similar design in this area are failing quicker than predicted by the program. The discrepancy is believed to be due to the conservative weight distribution which was used to calculate equivalent axle loads. The weight tables that were used are averages compiled by the Department from the loadometer station in Nacogdoches and account for all types of trucks which use that particular roadway. The traffic found on FM 1375, which now includes baseline traffic and national forest timber traffic, is believed to be significantly heavier than that represented by these weight tables. According to representatives of the industry, the average gross weight of the timber trucks hauling from the subject site is approximately 100,000 pounds. As more weight information is gathered in future phases of this study, a better estimate of pavement performance is anticipated.

Nonetheless, the case study demonstrates the method in which such special-use traffic generaters can be analyzed. The results can be used in scheduling maintenance and in selecting appropriate rehabilitation strategies for various classes of roadway. Trip generation information can also be used in the traditional application of calculating traffic volume estimates and projections for a specific generator. Although the sizes and other characteristics of specific special-use activity centers may vary from those examined in this study, the approach to evaluating the traffic impact will be the same. Additional research is planned in these same industries so that a more complete data base will be available to maintenance and planning personnel.

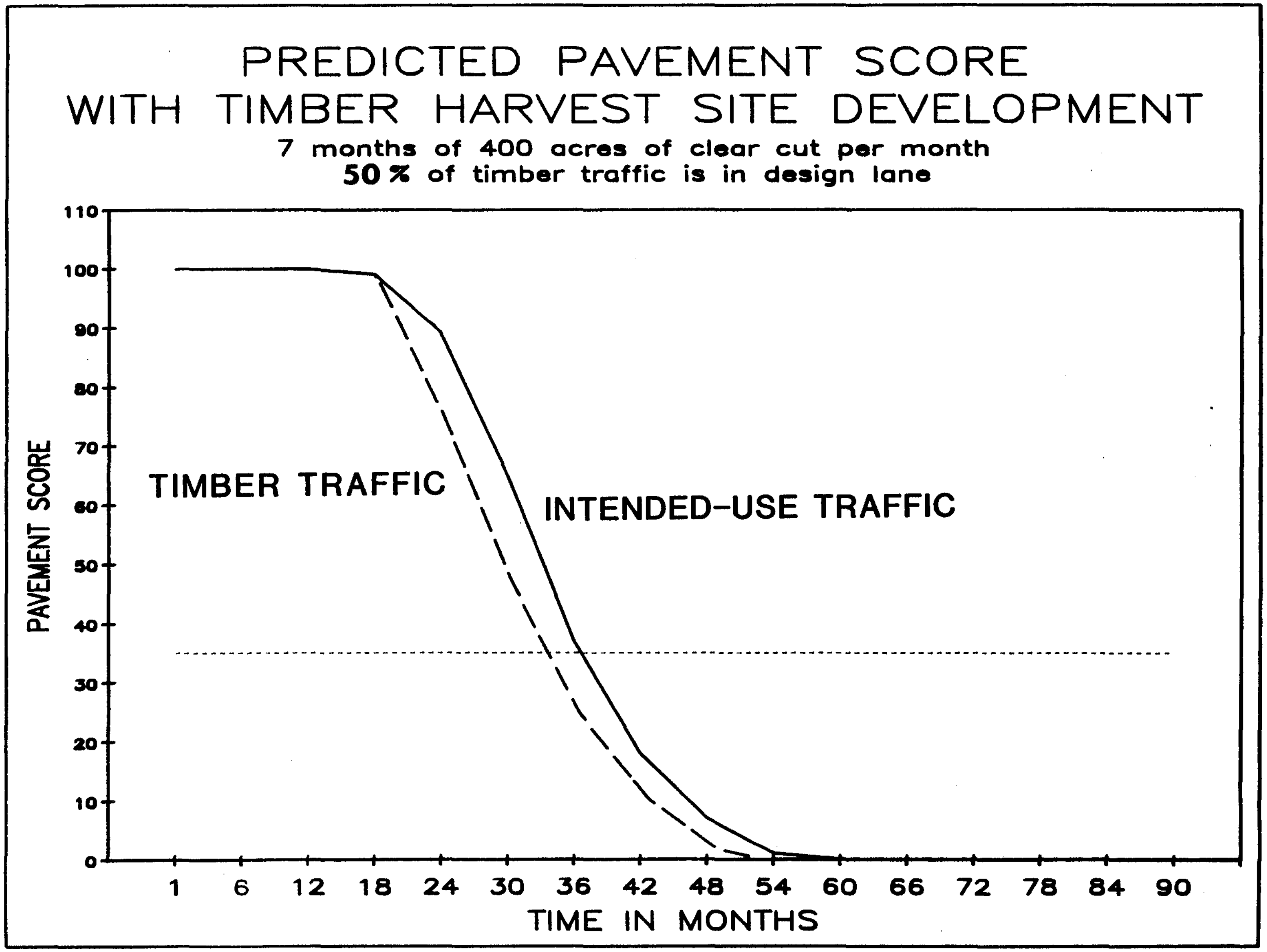


Figure 4.2.2 Predicted Pavement Score with Timber Harvest Site Development

4.3 TRIP GENERATION

4.3.1 Activity Center. For each commodity included in this study an activity center was selected for study. For several of these commodities, more than one activity center could have been chosen. A selection process using the following criteria was used:

(1) Those found early in the series of processes for the commodity;
(2) Those which generate a significant number of trips; and
(3) Those representing a fairly widespread problem in the State.

The number of trips generated by activity centers was determined by site interviews, telephone interviews, or manual traffic counts. Although the data in all cases were limited, preliminary information was established. Future research will expand the data base and provide additional information to predict the traffic impact of those activity centers.

4.3.2 Special-Use Trip Generation. Table 4.3.1 summarizes the trip generation factors previously stated in other parts of this study. Trip generation factors in the table are given on a daily basis. In the case of timber cutting sites, an acreage basis is preferable because of the additional variability caused by the weather, the size of the contractor, and a variable haul distance to the mills. A clear-cutting site will generate four to six 3-S2 trips per acre, while a selective-cutting site will generate two to four 3-S2 trips per acre. The number of passenger car (PC) trips generated are fairly constant on a time basis at 5, 10, and 20 respectively for small, average, and large contractors.

The unit of commodity measure in each industry is the truck trip. Since the characteristics of each vehicle vary by industry, a "truck trip" is not the same for all industries. Loads, axle spacings, haul distances, and characteristics of each commodity cause a difference in impact for each industry. For example, limestone aggregate is more weight intensive than livestock. However, the axle spacing for 3-S2 limestone trucks is less than 3-S2 livestock trucks. Because of the Texas bridge formula, the 3-S2 limestone haulers cannot legally gross 80,000 pounds since the wheelbase is too short. On the other hand, the livestock haulers use longer trailers and can therefore legally gross 80,000 pounds.

4.3.3 Special-Use Trip Matrix. Table 4.3.2 is a summary of information about the movement of each of the selected special-use commodities. Some of the information has not yet been gathered but will be in future phases of this project. An additional variable which will be measured is daily variation of trips. Vehicle classification count data will be collected at key locations three to four times per year over a three-year period.

TABLE 4.3.1 SPECIAL-USE TRIP GENERATION

LOCATION (ACTIVITY CENTER)	NUMBER OF ONE-WAY TRIPS PER DAY				MAXIMUM NUMBER OF TRUCKS
	PC	SU	3-S2	OTHER TRUCKS	
TIMBER MILLS					
Paper	1,800	110	400	15	580
Particle Board	650	30	210	10	280
Plywood Mill	650	10	255	0	350
Large Sawmill	---	0	200	0	300
Average Sawmill	240	0	100	0	160
GRAIN					
Elevator	8-10	145-270	16-30	0	300
BEEF CATTLE					
Large Feedlot	110-140	--	110	--	--
Average Feedlot	50-60	--	40	--	--
PRODUCE					
Large Distributor	400-500	200-240	150-200	--	600
Average Distributor	120	90	130	--	
POULTRY					
Processing Plant *	280	--	32	--	--
COTTON					
Gin	--	30	6	8-10	100
SAND/GRAVEL					
Large Pit	140	40	710	--	1,100
Average Pit	--	20	350	--	550
LIMESTONE					
Large Quarry	800	--	1,800-2,000	--	2,800
Average Quarry	300	--	900	--	1,400
LIGNITE PIT					
Small	50	--	140	--	160
URANIUM	--	--	--	--	--
IRON ORE	--	--	--	--	--

* 8-hour shift

4.4 VEHICLE WEIGHTS AND SPECIFICATIONS

4.4.1 **Typical Vehicle Weights.** Table 4.4.1 is a tabulation of axle weights and gross weights of most of the vehicles used in the special-use industries. These weights were gathered from several sources including Department of Public Safety weight personnel, contacts with public agencies and contacts with industry personnel. These data are approximations in some cases; additional data collection will be necessary to improve the reliability of these findings.

4.4.2 **Typical Vehicle Specifications.** Table 4.4.2 gives typical dimensions and capacity in volume and weight of many special-use vehicles. Standard width for semi-trailers, trailers, and truck beds is 96 inches (8 feet). The Surface Transportation Assistance Act (STAA) of 1982 allows wider trailers (and trucks) of 102 inches (8'-6") for use on certain specified roadways. A typical maximum length for semi-trailers has been 40 to 45 feet. The STAA and Texas House Bills 1601 and 1602 provide for a maximum length of tractor plus semi-trailer of 65 feet with few exceptions. The maximum semi-trailer length is now set at 57 feet. The maximum length of a trailer or semi-trailer is 27 1/2 feet when operated in a truck-tractor, semi-trailer, and trailer combination. An exception to the overall length limitation for special-use industries is in the case of unrefined timber. In this case the maximum length is set at 90 feet, but these vehicles cannot legally haul the timber for a distance greater than 125 miles.

The standard maximum overall height for vans and livestock haulers is 13 feet-6 inches. Other options are often available such as 12 feet-6 inches and 13 feet. The capacity of each trailer by volume is governed by its shape, legal limitations governed by STAA and the Texas Bridge Formula (given in the Appendix), and by how the trailer is loaded and unloaded. Some useable haul space is sometimes lost by the loading/ unloading mechanism, such as the ramps used to move livestock into or out of this trailer. Another example is the typical grain trailer which dumps from the bottom. The floor of this trailer is sloped to facilitate dumping. Since the bottom is not flat, the carrying capacity varies among the vehicles.

The capacity by weight of most special-use vehicles is given by the state weight laws rather than by vehicular volume constraints. Exceptions are cotton hauled from the gin or compress and chickens hauled from the grower to the processing plant. Weight-intensive commodities such as timber, sand/gravel, and crushed stone can very easily be loaded to the point of exceeding the maximum legal weight.

Truck and truck-tractor characteristics vary only slightly from one manufacturer to another. Two basic cab types are the conventional cab and the cab-over-engine (C-O-E) type which are both produced by all the major manufacturers. The conventional cab has the engine in front of the cab which adds length to the truck, whereas the C-O-E has the cab directly over the engine. Both of these cab types are found in truck-tractors, whereas the conventional cab is more common in single unit trucks.

TABLE 4.3.2 SPECIAL-USE TRIP MATRIX

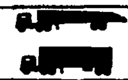
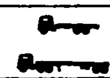
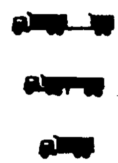
INDUSTRY	ORIGIN	DESTINATION	RAD. OF INFLUENCE		TYPE OF TRUCK USED	SEASONAL VARIATION		RAIL USAGE
			Ave.	Max.		PEAK	OFF-PEAK	
TIMBER	Cutting Site	Mills	50	120		Dry Season	Rainy Season	2-80%
GRAIN	Farms	Elevator	20	50		May/July	Winter	2-30%
BEEF CATTLE	Farms/Ranches	Feedlot	600	1,000		N/A	N/A	Negligible
PRODUCE	Fields	Distributor	15	50		Mar/Apr	Aug/Sep	Negligible
POULTRY	Growers	Processors	20	50		Jan/Oct	Nov/Dec	Negligible
COTTON	Fields	Gin	15	25		Sep/Dec	None Ginned	West Coast Only
SAND/GRAVEL	Pit	Construction Site	60	100		N/A	Winter	20%
LIMESTONE	Quarry	Construction Site	125	160		N/A	Winter	25%
LIGNITE	Mine	Power Plant	30	200		---	---	---
URANIUM	Mine	Processing Plant	20	--		---	---	---
IRON ORE	Mine	Crusher, Steel Mill	20	50		N/A	Winter	None

TABLE 4.4.1 TYPICAL SPECIAL-USE AXLE AND GROSS WEIGHTS

VEHICLE DESCRIPTION	LOAD: 1000 POUND									
	STEER AXLE	2ND AXLE GROUP	NO. OF AXLES	3D AXLE GROUP	NO. OF AXLES	4TH AXLE GROUP	NO. OF AXLES	5TH AXLE GROUP	NO. OF AXLES	GROSS WEIGHT
3-S2 Timber Flatbed	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
3-S2 Timber Foldup	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
	12	54	2	54	2					120
3-S2 Timber Pulpwood	10	30	2	30	2					70
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
3-S2 Timber Van	10	30	2	30	2					70
Chip Hauler	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
2-S2 Timber	12	18	1	32	2					62
(4-Axles)	12	18	1	40	2					70
	12	18	1	50	2					80
2-S1-2 Timber	10	16	1	16	1	16	1	16	1	74
Flatbed	12	17	1	17	1	17	1	17	1	80
	12	19	1	19	1	20	1	20	1	90
	12	22	1	22	1	22	1	22	1	100
SU-1 Timber	12	20	1							32
(2 Axles)	12	28	1							40
SU-2 Timber	12	30	2							42
(3 Axles)	12	36	2							50
	12	46	2							60
SU-1 Grain	12	20	1							32
(2 Axles)	12	28	1							40
	12	38	1							50
SU-2 Grain	12	30	2							42
(3 Axles)	14	36	2							50
	14	46	2							60
3-S2 Grain	10	32	2	32	2					74
(5 Axles)	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
3-S2 Beef Cattle	10	32	2	32	2					74
(Possum Belly)	12	34	2	34	2					80
	12	39	2	39	2					90
3-S2 Beef Cattle	10	32	2	32	2					74
Grain	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
SU-2 Beef Cattle	12	30	2							42
Grain	14	36	2							50
	14	46	2							60
SU-2 Produce	12	26	2							42
(3 Axles)	14	36	2							50
	14	40	2							54

TABLE 4.4.1 TYPICAL SPECIAL-USE AXLE AND GROSS WEIGHTS (Continued)

VEHICLE DESCRIPTION	LOAD: 1000 POUND									
	STEER AXLE	2ND AXLE GROUP	NO. OF AXLES	3D AXLE GROUP	NO. OF AXLES	4TH AXLE GROUP	NO. OF AXLES	5TH AXLE GROUP	NO. OF AXLES	GROSS WEIGHT
Field Trailer	5	7	1	10	2					22
	8	7	1	15	2					30
	8	7	1	25	2					40
3-S2 Produce Reefer	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
SU-1 Poultry (2 Axles)	12	9	1							21
	12	16	1							30
	12	26	1							40
3-S2 Poultry Flatbed	10	18	2	18	2					46
	12	19	2	19	2					50
	12	24	2	24	2					60
	12	29	2	29	2					70
	12	34	2	34	2					80
3-S2 Poultry Reefer	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
SU-2 Cotton Mod. Truck	10	14	2							24
	12	18	2							30
	12	28	2							40
	12	38	2							50
Cotton Field Trailer	4	4	1	4	1	4	1			16
	4	5	1	5	1	5	1			19
	4	8	1	8	1	10	1			30
3-S2 Cotton Flatbed	10	30	2	30	2					70
	12	34	2	34	2					80
	12	39	2	39	2					90
3-S2 Cotton Van (5 Axles)	10	30	2	30	2					70
	12	34	2	34	2					80
SU-2 Sand/Gravel/ Pup	12	32	2	32	2					76
	14	33	2	33	2					80
	14	38	2	38	2					90
	14	48	2	48	2					100
	14	53	2	53	2					110
3-S2 Sand/Gravel Dump (5 Axles)	10	30	2	30	2					70
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
	12	54	2	54	2					120
SU-2 Crushed Stone/ Pup	12	32	2	32	2					76
	14	33	2	33	2					80
	14	38	2	38	2					90
	14	48	2	48	2					100
	14	53	2	53	2					110
3-S2 Crushed Stone Dump (5 Axles)	10	30	2	30	2					70
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
	12	54	2	54	2					120
3-S2 Lignite Flatbed	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100

TABLE 4.4.1 TYPICAL SPECIAL-USE AXLE AND GROSS WEIGHTS (Continued)

VEHICLE DESCRIPTION	LOAD: 1000 POUND									
	STEER AXLE	2ND AXLE GROUP	NO. OF AXLES	3D AXLE GROUP	NO. OF AXLES	4TH AXLE GROUP	NO. OF AXLES	5TH AXLE GROUP	NO. OF AXLES	GROSS WEIGHT
3-S2 Lignite Lowboy (5 Axles)	10	22	2	22	2					54
	12	24	2	24	2					60
	12	29	2	29	2					70
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
	12	54	2	54	2					120
3-S3 Lignite Lowboy (6 Axles)	10	22	2	45	3					77
	12	22	2	46	3					80
	12	30	2	48	3					90
	12	36	2	52	3					100
	12	40	2	58	3					110
	12	44	2	64	3					120
	12	48	2	70	3					130
	12	52	2	76	3					140
	12	56	2	82	3					150
	12	60	2	88	3					160
	12	60	2	98	3					170
3-S4 Lignite Lowboy (7 Axles)	10	22	2	45	4					77
	11	23	2	46	4					80
	12	27	2	51	4					90
	12	30	2	58	4					100
	12	33	2	65	4					110
	12	36	2	72	4					120
	12	40	2	78	4					130
	12	43	2	85	4					140
	12	46	2	92	4					150
	12	50	2	98	4					160
	12	53	2	105	4					170
	12	56	2	112	4					180
3-S5 Lignite Lowboy (8 Axles)	10	22	2	55	5					87
	11	23	2	56	5					90
	12	26	2	63	5					100
	12	28	2	70	5					110
	12	31	2	77	5					120
	12	34	2	84	5					130
	12	38	2	90	5					140
	12	41	2	97	5					150
	12	43	2	105	5					160
	12	46	2	112	5					170
	12	48	2	120	5					180
	12	51	2	127	5					190
	12	52	2	130	5					200
SU-2 Lignite Redi-Mix	16	34	2							50
	20	44	2							64
3-S2 Lignite Dump (5 Axles)	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
3-S2 Uranium Dump (5 Axles)	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
3-S2 Uranium Flatbed	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
3-S2 Iron Ore Dump (5 Axles)	10	32	2	32	2					74
	12	34	2	34	2					80
	12	39	2	39	2					90
	12	44	2	44	2					100
	12	49	2	49	2					110
SU-2 Iron Ore Dump (3 Axles)	12	42	2							54
	12	48	2							60

Table 4.2.2 Typical Trailer and Truck Bed Characteristics

		TRAILER/TRUCK BED DIMENSIONS (FT)			CAPACITY	
COMMODITY	VEHICLE DESCRIPTION	WIDTH (FT)	LENGTH (FT)	OVERALL HEIGHT (FT)	(1,000) CUBIC FEET	(1,000)** Pounds
Timber	3-S2 Fold-up	8.0	35 - 45	---	---	80
	3-S2 Pulpwood	8.0	35 - 40	---	---	80
	3-S2 (Chip) Van	8.0	38 - 40	12.8	2.40	80
	3-S2 Flatbed	8.0	32 - 45	4.7*	---	80
	SU-1	8.0	8 - 10	9.6	---	20
	SU-2	8.0	10 - 14	9.6	---	30
Grain	SU-1	8.0	8 - 10	9.6	.32 - .40	20
	SU-2	8.0	10 - 14	9.6	.40 - .56	30
	3-S2 Grain	8.0	39 - 42	9.6	1.56 -1.68	80
Beef Cattle	3-S2 Possum Belly	8.0	44 - 50	13.5	up to 4.00	52
	3-S2 Grain	8.0	39 - 42	9.6	1.56 - 1.68	80
	SU-2 Grain	8.0	10 - 14	9.6	.40 - .56	30
Produce	SU-2	8.0	10 - 14	9.6	.40 - .56	30
	Tractor/Field Trailer	7.0	10 - 12	8.0	.34	---
	3-S2 Reefer	8.0	30 - 50	12.5 - 13.5	1.87 - 3.90	80
Poultry	SU-1	8.0	8 - 10	---	---	20
	3-S2 Flatbed	8.0	32 - 50	4.7*	2.25 - 3.90	80
	3-S2 Van	8.0	44 - 50	13.5	up to 3.17	80
Cotton	SU-2 Module	8.0	37.5	13	3.90	46
	Field Trailer	7.0	---	---	---	15
	3-S2 Flatbed	8.0	32 - 45	4.7*	---	80
	3-S2 Van	8.0	38 - 50	12.8	3.17	80
Sand/Gravel	SU-2 w/Pup	8.0	24 - 28	8	.82	80
	3-S2 Dump	8.0	24.3-35	8.9 - 9.7	.72 - 1.22	80
Crushed Stone	SU-2 w/Pup	8.0	24 - 28	8	.82	80
	3-S2 Dump	8.0	24.3-35	8.9 - 9.7	.72 - 1.22	80
Lignite A) Const.	3-S2 Flatbed	8.0	32 - 50	4.7*	---	80
	3-S2 Lowboy	8.0	32 - 45	1.7 - 3*	---	70
	3-S3 Lowboy	8.0	37.3- 47.8	3.5*	---	120
	3-S4 Lowboy	8.0	46.8- 48.2	3.5*	---	150
	S-S5 Lowboy	8.0	51.6	3.9*	---	150
	SU-2 Redi-Mix	8.5	14.9- 20	12.1	.54 (12 cu. yd.)	49
B) Power	3-S2 Dump	8.0	24.3- 35	8.9 - 9.7	.72 -1.22	80
Uranium	3-S2 Dump	8.0	24.3- 35	8.9 - 9.7	.72 -1.22	80
	3-S2 Flatbed	8.0	32 - 50	4.7*	---	80
Iron Ore	3-S2 Dump	8.0	24.3- 35	8.9 - 9.7	.72 -1.22	80
	SU-2 Dump	8.0	12 - 16	8.9 - 9.7	.72 -1.22	40

* For flatbeds and lowboys, the height is the floor level.
** Weight of load only.

Wheelbases for a three-axle truck-tractor vary from 11 feet-6 inches on the C-O-E style to 19 feet on the convention cab models. The corresponding overall length is 18 feet and 28 feet for these two truck-tractors. The engines which are available in these vehicles are numerous. The typical horsepower range is 200 to 300, with even larger engines in the 400 to 600 HP range also available. Some manufacturers will custom build a truck-tractor to the customer's satisfaction.

Three-axle single-unit trucks are quite similar in wheelbase, engine/drive train options to truck-tractors. Other options in these SU trucks include longer wheelbase and, in some cases, gasoline engines. The two-axle single unit trucks have shorter wheelbases and smaller engines as a general rule. The specific wheelbases are in the range of 10 feet 6 inches to 21 feet. Horsepower ranges are from 150 to 225.

4.5 ECONOMIC AND ENFORCEMENT ISSUES

4.5.1 Economic Considerations. Tariffs are the amount paid to a trucker for hauling a certain commodity a specified distance. The Texas Railroad Commission sets the minimum tariff. A schedule is also established for payment of hauling specific commodities.

Sometimes the tariff paid truckers for shipment of a commodity is considered insufficient by the trucking industry. In a recent example, the tariff being paid truckers to haul crushed stone was the minimum established by the Railroad Commission. However, the truckers had apparently been hauling loads heavier than legally allowed by the bridge formula (which is based on the number of axles and axle spacing). Recent legislation, which allowed prosecution of the shipper and receiver of illegally loaded vehicles, resulted in these trucks not being loaded as heavily as before. Since the truckers were paid on a weight basis for hauling, they were not getting paid the same as before. From an economic point-of-view, they felt they were in a considerably worse situation, and consequently went on strike. The shipper was forced to increase the tariff to accommodate the truckers' demands.

There are currently several important issues and trends facing the trucking industry during the 1980's. Change in the industry has been brought about by deregulation and by national economic conditions such as the recent recession. According to the October, 1983 AASHTO Standing Committee Task Force Final Report on Deregulation of the Transportation Industry (20), the financial condition of the motor carrier industry has worsened. It is not possible, however, to separate the economic impacts from the impacts of deregulation.

Several other trends have become apparent during the past few years. There has been continued competition with the railroads. Piggyback traffic is one of the fastest growing segments of rail business. The overall rail traffic diverted from road to rail was 240 million ton-miles in 1982, a substantial increase over 1981 diversions, but primarily due to railroad deregulation. Therefore, this high rate of increase is not expected to continue. The increase in the number of owner-operators and small fleets obtaining operating authority was significant--17,000 in 1979 and 23,000 in 1982. A similar increase has occurred in the number of firms acquiring 48 state authority. (20)

4.5.2 Enforcement Issues. The Texas Department of Public Safety (DPS) has worked to enforce speed limits, licensing requirements, weight limits, and other standards of the trucking industry. One limitation to the efforts of DPS has been the lack of manpower and equipment to adequately check overweight and otherwise illegal truckers. The License and Weight Division of DPS currently operates statewide with less than 200 officers who use 18 sets of semi-portable platform scales and 165 sets of roll-over scales on state roads. The limitations in manpower reduce the enforcement effort substantially such that only 4 percent of the violators are likely to be apprehended. According to DPS records, there are now approximately 52,000 cases cited per year with an average fine of only $112.

Truckers have avoided fines in several ways. These include: using alternate routes which bypass scales, stopping enroute until DPS moves, lowering tire pressure in outside tires (especially when roll-over scales are used), and hauling at night. In a recent survey conducted from midnight to 6:00 AM by SDHPT, 95 percent of the truckers were exceeding the posted speed limit and approximately 50 percent were overweight.

Recent legislation has made the DPS effort only marginally more successful. For a first offender, a truck driver is taken to a JP (Justice of the Peace) Court where he can be fined a minimum of $100 for being overweight or a maximum of $150. The minimum was recently increased from $25. This has not yet proven effective since many violators are still not being caught, or if sent to JP Courts, are still not prosecuted. The fine for a second conviction is not less than $150 nor more than $250, while a third conviction should mean a fine of at least $200 but not more that $500 for the overweight violation. (House Bill 1114)

This same House Bill provides for shippers liability where intent to violate the state weight laws can be proved. This has been construed to mean that if the loaded vehicle exceeds the gross vehicular weight limit by 15 percent or more, then the shipper can be held accountable. Exceptions to this rule include agricultural and timber commodities prior to processing. Yet another consideration with these commodities is the fact that overweight trucks cannot be unloaded on the spot and made legal as in other goods movement.

A crucial need in enforcement for truck traffic is a number of well designed, strategically placed "weigh-strips." Without these, DPS cannot adequately perform the enforcement task, even if the personnel and equipment are plentiful. The weigh areas must be built in locations which are safe and convenient for both the Department and DPS in their weight gathering operations. Project 424, "Evaluation of Texas Truck Weighing Programs," will provide information on preferred locations for future truck weight stations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Without question, the commodities identified in this study have a significant impact on the State's economy. Further, the special-use truck will be the primary mode of transport for these products. Accepting these presumptions, the information contained in this report has been assembled in a fashion to assist the Department in the areas of planning and research, geometric design, traffic operations, and pavement management. In particular, the ability to characterize the unique travel patterns, vehicle configurations, and trip generation rates can be used in decisions regarding appropriate design and rehabilitation alternatives.

The initial findings demonstrate the variability of industry characteristics and the requirements of a specific commodity. Each special-use activity generates different traffic; most are unique in vehicle type, size, and number. It is therefore suggested that the information collected in this effort be used to supplement existing data and design and maintenance techniques. The unusual characteristics of special-use activity centers warrant individual consideration when forecasting truck traffic on the highway segment.

Findings of this investigation can be used for several purposes. The collected data will assist in general planning procedures, roadway design considerations, and pavement design and maintenance. This initial effort has identified the unique traffic characteristics of special-use truck traffic demands. Among these characteristics are trip generation rates, vehicle classifications, axle configurations, and axle weight estimates.

5.1. RECOMMENDATIONS FOR IMPLEMENTATION

Practical application of the procedures developed in this effort can be used at both the Division and the District level of the SDHPT. The findings are relevant to district administrative, design, and maintenance engineers to accommodate increased traffic demand caused by special-use activities along low volume roadways.

5.2 PHASE II CONSIDERATIONS

This Interim Report summarizes the findings of the initial phase of the research. The identification of special-use truck traffic has been done; industry and vehicle characteristics have been determined for each of the selected activities. The trip generation factors and radius of influence have been approximated through agency contacts, limited traffic counts, and interviews with industry representatives. In order to provide statistical reliability for these data, a suitable sampling plan is being devised.

Following are the objectives approved by the Department for future phases of this effort:

1. Develop and refine a suitable study design.
2. Determine traffic characteristics and axle distribution.
3. Create preliminary density maps.
4. Data reduction and analysis.
5. Demonstrate utility of collected data through case study example.
6. Prepare Interim and Final Reports.

5.3 INTERPRETATION

The findings of the initial phase are limited, especially for certain commodities. Poultry and uranium will be eliminated from the study. Cotton, lignite, and iron ore will be carefully considered in future efforts since their relative impacts need further evaluation. The construction phase of lignite power plants can significantly impact a local area. The construction and power production phases should be evaluated in separate studies. The initial results have provided a relative measure of activity (density) of each special-use commodity in Texas.

5.4 RECOMMENDATIONS FOR FUTURE RESEARCH

Future research needs relative to the investigation undertaken in this study are as follows: to measure axle weights in the movement of each commodity, note trends in special-use activities, examine impact of lignite power plant construction, and analyze grain movement in the state of Texas.

5.4.1 Axle Weight Measurements in Each Commodity Flow. The use of existing loadometer data to design roads near special-use activity centers is not adequate. Definitive weights of vehicles must be determined by some reliable means. The use of DPS platform scales, if strategically placed and timed, can be effective in acquiring accurate weights. Weigh-in-motion devices should also be used as they become available.

5.4.2 Establish Trends in Special-Use Activities. Commodity flows which are not closely monitored by a public agency are very difficult to study. For example, the majority of timber being cut in Texas is on private land and is therefore very difficult to monitor by traditional methods. The use of aerial photography or satellite imagery should be investigated.

5.4.3 Examine Impact of Lignite Power Plant Construction. The use of lignite for the production of electrical energy is expected to increase dramatically during the next 20 years. Gearing up for power production involves preparing the surface mining operation as well as construction of the power plant facility. Both of these operations occur simultaneously over a period of 2 to 4 years. A study would either involve one site from start to finish or several sites which are at various stages of completion.

5.4.4 Analysis of Grain Movement in the State of Texas. Grain movement around the state is highly variable and is influenced by weather, economic factors, and demand from markets outside the state. The modal split also varies. An obvious need exists to study grain movement in order to limit the uncertainty of existing information.

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7.0 APPENDIX

7.1 Annotated Bibliography

7.2 Computer Program--Pavement Damage Caused by Special-Use Activities

7.3 Texas Bridge Formula

7.1 Annotated Bibliography

7.1 ANNOTATED BIBLIOGRAPHY

7.1.1 Timber

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New weight limit changes proposed by the state are compared to present limits as they would impact the log industry and classes of haulers, depending on the truck type and region. The effect on bridge loading of the proposed weight schedule is also evaluated. A log truck survey was conducted in this study.

Dykstra, Dennis P., and J. J. Garland, "Log Truckers Finding Payloads Reduced by Revised Weight Law," Forest Industries, April 1978.

Based on a survey of the log-trucking industry, this article examines recent changes in Oregon's weight table and their economic effect on the log hauling industry. From the results of the survey, legislative compromises in the weight table were developed.

Dykstra, Dennis P. and J. J. Garland, "Log Trucking in Oregon--A Survey," Transactions of American Society of Agricultural Engineers, St. Joseph, Michigan, Vol. 21, No. 4, pp. 628-632, 1978.

To estimate the economic impact of proposed state changes in legal highway weight limits on the Oregon log trucking industry, state log transportation methods were surveyed. The types of log trucks surveyed are the conventional, the self-loader, and the short logger. Statistics include number of trucks and truck operators, as well as axle measurements, haul loads, and economic costs of trips.

Harvest Trends, 1970-1982, Texas Forest Service, Texas A&M University System, College Station, Texas.

These annual reports of the volume, type, and use of harvested timber evaluate growth trends in the Texas lumber industry.

Publications Directory: Technical Releases, Technical Papers and Special Projects, 1958-1982, American Pulpwood Association, Washington, D. C., January 1983.

Pulp and paper industry publications are classified and listed into technical release, technical paper, and special project sections in this annotated bibliography. The following technical papers listed in the Directory are available at the Texas Transportation Institute:

Archer, John J., "Future Transportation Systems," No. 78-P-38.

Izlar, Bob, "Federal, State Trucking Regulations Confuse Wood Transportation Outlook," No. 80-p-43.

Koger, Jerry L., "Transportation Methods and Costs for Sawlogs, Pulpwood Bolts, and Longwood," No. 81-P-53.

New, R. D., "Prerequisites for Improving Pulpwood and Chip Transportation," No. 70-P-27.

Olson, I. S., "Freight Rate Trends and Their Effect on the Forest Products Industry," No. 76-P-7.

Rolston, K. K., "Pulpwood Transportation Trends," No. 81-P-34.

Walters, R. W., "Prerequisite for Improving Pulpwood and Chip Transportation," No. 79-P-26.

Wilson, Fillmore G., "Truck Transport of Longwood Calls for New Equipment and Regulation," No. 80-P-41.

Zitto, Fred M., "A Comparison of Laws and Tariffs in the Southwestern Technical Division," No. 80-P-4.

<u>Texas Forest Industries Directory, 1982</u>, Texas Forest Service, Texas A&M University System, College Station, Texas, 1982.

This directory lists all mills by type and by county and includes maps, especially of east Texas.

Watson, W. F. and Matney, T. G., "States' Truck Weight Laws Affect Manufacturing Costs, Stumpage Prices," <u>Tree Talk</u>, Mississippi Forestry Association, Mississippi State, Mississippi, <u>Winter 1981</u>.

This article compares Mississippi's lower legal axle and gross truck weights to Louisiana's weights. Additional log hauling costs are shown to place Mississippi manufacturers at a disadvantage.

Weaver, G. H., et al., <u>1979 Pulpwood Producer Census</u>, <u>Southwest and Southeast Technical Divisions of the American Pulpwood Association</u>, Mississippi State University, Mississippi State, Mississippi, January 1981.

Marked changes in the pulpwood industry between 1976 and 1979 are reflected in the census which includes personal characteristics of producers, characteristics of individual pulpwood operations, and equipment inventories.

7.1.2 Agriculture

Amarillo Livestock Reporter, June 29, 1984, Vol. 2, No. 26.

This newspaper contains feeder and slaughter cattle reports, carlot beef reports, a summary of the grain market report, and cattle costs. It also features news articles of personal and professional interest to cattle ranchers.

Cattle Feeders Annual, Texas Cattle Feeders Association, Amarillo, Texas, 1983.

This publication contains informative articles for cattle feeders and the Cattle Feeders Directory, including beef facts. An 18 x 20 inch map, "Texas Cattle Feeder Association Member Feedyards," is also available.

Directory of Texas Agricultural Cooperatives, 1983-84, Texas Department of Agriculture, Austin, Texas, 1984.

Fuller, Stephen, Mechel Paggi, and Dwayne Engler, Texas Wheat Flows and Transportation Modes, 1975, The Texas Agricultural Experiment Station, The Texas A&M University System, College Station, Texas, 1975.

This study describes the distribution patterns, or flow, of wheat among producers, grain elevators, flour mills, and ports within and outside Texas. While railroads were the major interstate transporter of Texas wheat, trucks play an important role in intrastate movement. The modal split for interstate grain movement was about 50/50 trucks versus rail.

Ginner's Red Book, Texas Cotton Ginner's Association, 35th Ed., Dallas, Texas, 1980.

Excerpts in Project 420 files include all Texas gins in the Amarillo area, plus a table of types of gins in each state district.

Membership Directory, 1983, Texas Citrus and Vegetable Association, McAllen, Texas, 1983.

Officers in the Texas Citrus Association are first listed. Member producers are next listed, along with their commodities, addresses, and phone numbers.

1982 Cash Receipts, Prices Received and Paid by Farmers, Texas Crop and Livestock Reporting Service, Texas Department of Agriculture and U. S. Department of Agriculture, Austin, Texas, 1982.

Section I of this bulletin contains total cash receipts and government payments by commodity for farmers and ranchers and by commodity groups and government payments. Prices received for various crops and small livestock are in Section II. Section III includes

prices paid by farmers and ranchers in Texas for real estate, wages, and utilities.

1982 Feedlot Study, prepared by the District 4 Office of the State Dapartment of Highways and Public Transportation, Amarillo, Texas.

This study was on the effects of traffic generated by the feedlot industry on the roads of District 4. The history of the Texas cattle industry, as well as a description of the feedyard and its economic value to a community, are included. This study also lists the economic factors of each county. Maps and tables show locations of 5000 or higher capacity feedlots and packing plants.

1982 Texas County Statistics, Texas Crop and Livestock Reporting Service, Texas Department of Agriculture and U. S. Department of Agriculture, Austin, Texas, 1982.

This bulletin presents complete agricultural statistics by crop for the state, district, and county.

1982 Texas Fruit and Pecan Statistics, Texas Crop and Livestock Reporting Service, Texas Department of Agriculture and U. S. Department of Agriculture, Austin, Texas, 1982.

The year's production and price of Texas citrus, peaches, and pecans are described and compared with previous years and with other states' production.

1982 Texas Small Grains Statistics, Texas Crop and Livestock Reporting Service, Texas Department of Agriculture and U. S. Department of Agriculture, Austin, Texas, 1982.

This publication presents county estimates of wheat, oats, barley, and rye for 1981-82 crop years.

1982 Texas Vegetable Statistics, Texas Crop and Livestock Reporting Service, Texas Department of Agriculture and U. S. Department of Agriculture, Austin, Texas, 1982.

This bulletin presents vegetable acreages by county and vegetable production by areas, as well as monthly and average season prices, of the major vegetable crops grown in Texas.

Marketing Texas Lower Rio Grande Valley Vegetables 1982-83, Federal-State Market News Service, Texas Department of Agriculture and U. S. Department of Agriculture, Weslaco, Texas, 1983.

This bulletin summarizes the 1982-83 vegetable and fruit season in South Texas, including shipments, prices, and distribution.

Texas Cattle Feeding, The Genesis of an Agricultural Giant, Texas Cattle Feeders Association, Amarillo, Texas, 1977.

This booklet tells the story of the Texas cattle industry from the early longhorns to today's large feedlot operations.

Texas Grain and Feed Association 1980-1981 Directory, Fort Worth, Texas, 1981.

Members are listed and identified by type of business and elevators by storage capacity. This directory also notes the railroads serving the cities where members are located.

Texas Grain Warehouses, Texas Department of Agriculture, Austin, Texas, 1981-82.

Arranged by county, this directory of Texas grain warehouses includes locations, capacities in bushels, and local managers.

Texas Vegetable Report, Federal-State Market News, Texas Department of Agriculture and U. S. Department of Agriculture, Weslaco, Texas, May 24, 1984.

Issued daily, this bulletin shows the demand for Texas vegetables and fruits and the shipments of each commodity this season and last season, including Mexican produce coming into and through Texas. It also gives the market prices and trends for Texas produce in major U.S. cities.

Vantassell, Larry W., Expanded Research SRS Data Bank, Texas Crop and Livestock Reporting Service, Texas Agricultural Experiment Station, Texas A&M University System, College Station, Texas, 1982.

This article summarizes the SRS Data Bank of agricultural statistics for each county in Texas from 1970 through 1982. Included are examples of production of crops and livestock from the SRS Data Bank.

7.1.3 Surface Mining

Information and Statistical Facts on Coal and Uranium Mining in Texas, Surface Mining and Reclamation Division, Railroad Commission of Texas, Austin, Texas, August 1982.

Texas' high production of coal, ninth largest among the states, and of uranium, third largest, is illustrated in this report. Maps and tables detail the production, exploration, and use of these minerals in utility plants. The effect of surface mining on land and vegetation and acres of land revegetated are also shown.

Mineral Resources of Texas, Bureau of Economic Geology, The University of Texas, Austin, Texas, 1979.

Geologic units containing regionally significant mineral resources in Texas are shown on this map. The locations of mineral resources currently being produced and of mineral resources produced in the past, as well as mineral occurrences that may or may not be of commercial significance, are pinpointed.

Taylor, T. J., Lignite-Fired Power Plant Projections: 1985-2000, Energy Policy Division, Texas Energy and Natural Resources Advisory Council, Austin, Texas, January 1983.

Based on the expected increased demand for lignite to fuel electric power plants, this report estimates projected lignite production in Texas from 1985-2000. Tables and maps show the estimated demand for electricity and the capacity of power plants, as well as resource blocks of lignite and coal. The resource blocks are located as close as possible to the areas needing electric power.

Texas Energy and Natural Resources Advisory Council Publications List, Spring 1983," Texas Energy and Natural Resources Advisory Council, Austin, Texas, 1983.

Publications from the Advisory Committees and the major TENRAC divisions are listed: Administration, Energy Policy, Natural Resources Policy, Technology Development, Energy Efficiency, and Energy Emergency Planning. Also included are publications from predecessor agencies of TENRAC in the areas of environmental and social programs, legal and regulatory programs, new technology programs, supply and demand programs, and technical and contract reports, as well as coordinated and special project reports.

Texas Railroads: 1982-1983 Update, Transportation Division, Railroad Commission of Texas, Austin, Texas, March 1983.

This rail plan update provides an overview of U.S. and Texas rail systems and evaluates particular Texas lines as being essential to the state's rail freight needs. The report describes projects Texas has rehabilitated, future possibilities of rehabilitation, and line segments which have changed status since the 1981 update. The

planning process used to evaluate a line segment for rail assistance and recent analyses of specific line segments are also included, as well as a Chapter on state rail passenger service.

Van Zandt, Thomas, et al., Community Impacts of Lignite and Coal Development in Texas: Legislative Report EDF-083, Texas Energy Development Fund, Texas Energy and Natural Resources Advisory Council, Austin, Texas, November 1982.

By 2000, the increased Texas lignite mining for generating electric power, more than coal mining, is expected to impose socioeconomic changes on local communities. This report presents information and suggests policies for state legislation and public response to help these communities. Part One summarizes Texas lignite mining and its use in power plants, as well as its growth impacts on communities. Part Two discusses and evaluates local and state capabilities and resources to cope with these impacts. Part Three compares the experiences of other western mining states and then presents policies which would reduce the socioeconomic impacts of lignite industrial growth on communities.

Ward, Albert E., "The Mineral Industry of Texas in 1980," Mineral Resource Circular No. 71, Bureau of Economic Geology, The University of Texas, Austin, Reprinted from Minerals Yearbook 1980, Bureau of Mines, U. S. Department of the Interior, Washington, D.C., June 1982.

Texas was the leading producer of cement, gypsum, magnesium chloride, native asphalt, stone, and sulfur, and the second highest producer of clay and salt in both 1980 and 1981. Each of these annuals describes the states' nonfuel mineral production by county and by mineral as well as the principal mineral producers.

Ward, Albert E., "The Mineral Industry of Texas in 1981," Mineral Resource Circular No. 72, Bureau of Economic Geology, The University of Texas, Austin, Texas, Reprinted from Minerals Yearbook 1981, Bureau of Mines, U. S. Department of the Interior, Washington, D. C., May 1983.

7.1.4 Trucks

The following bills are intended to bring Texas vehicle width and length laws into compliance with the Federal Surface Transportation Assistance Act of 1982:

"An Act Relating to Length Limitations on Certain Motor Vehicles and Combinations of Vehicles," Texas Statutory Documents, House Bill 1602, Austin, Texas, 1983.

"An Act Relating to Width Limitations on Motor Vehicles on Certain Highways," Texas Statutory Documents, House Bill 1601, Austin, Texas, 1983.

Annual Report, 1983, American Trucking Association, Washington, D. C., 1983.

This report describes the state of the industry and how it was affected by recent federal and state legislation and economic factors.

Barber, E. J., and L. L. Hildebrand of Peat, Marwick, Mitchell and Company, Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials, Federal Highway Administration, Report FHWA-1P-80-15, Washington, D. C., November 1980.

A hazardous material is defined as "a substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce . . ." The guide describes and illustrates routing methods for evaluating interstate highways, urban arterials, and rural highways for the risk that hazardous movements on them pose to nearby populations and property.

"Commercial Carrier Journal for Private Fleets and for Hire Trucking," reprinted from Commercial Carrier Journal, June 1983.

Three articles in this excerpt include: (1) an analysis of the 1982 financial disaster of the top 100 for-hire fleets; (2) trucking industry trends and statistics, including truck sales; and (3) a statistical analysis of the private fleets, including driver and mechanic wage rates, operating costs, and lists of private fleets by general type.

Cosby, Pamela J., A Synthesis and Annotated Bibliography, Rural Roads and Bridges in the South, Southern Rural Development Center and U. S. Department of Agriculture, Mississippi State, Mississippi, SRDC Synthesis, Bibliography Series No. 18, July 1983.

Part One describes the current status of Southern rural roads and bridges, emphasizing state and county efforts to cope with deteriorating conditions and limited revenues. Part Two is an annotated bibliography of recent literature on rural roads and bridges in the South.

Development of a Statewide Counting Program Based on the Highway Performance Monitoring System, Draft report, Peat, Marwick, Mitchell and Company, Federal Highway Administration, Washington, D.C., January 1984.

This report recommends and describes a cost-effective statewide traffic monitoring program based on the Highway Performance Monitoring System, including vehicle classification and truck weight data. Case studies in states which implemented the proposed program are included.

Directory of Rural Development Researchers in the South, Southern Rural Development Center, Mississippi State, Mississippi, SRDC Series No. 68, March 1984.

Researchers and their areas of research are listed in Part I by state and in Part II by subject area.

Hayden, Robert L., David I. Dickey, and Ray C. Jr., Erickson, A Study of Longer Vehicle Combinations, A Report to the Fifty-Fourth General Assembly of the State of Colorado, Colorado State Department of Highways, Denver, Colorado, January 1983.

The results of a one-year test of three types of longer vehicle combinations on Colorado Interstate highways are reported. Maximum weight was restricted to 80,000 pounds and maximum length to 105 feet. Data was collected on operational safety factors, fuel conservation, and transportation productivity. A statute to legalize longer vehicle combinations is included for the Colorado General Assembly to consider.

Interstate System Traveled-Way Traffic Map 1979, Federal Highway Administration, Washington, D. C., 1979.

Average daily traffic on rural sections of the traveled-way of the Interstate System is detailed. Four tables with this map show: (1) percent of mileage and travel in given years between 1964 and 1979 by selected categories; (2) percent change in vehicle miles of travel between 1978 and 1979; (3) 1979 average daily vehicle miles per mile of roadway; and (4) 1979 average daily vehicle miles of travel.

Kent, Perry M., and Mary T. Robey, 1975-1979 National Truck Characteristic Report, Federal Highway Administration, Washington, D.C., June 1981.

The results of the Annual Truck Weight Study done by the state highway agencies in cooperation with the Federal Highway Administration are presented in this booklet. At each location, all vehicles in the traffic stream were counted and classified. The number of axles and axle configurations for each truck type were also recorded. In 8-hour daylight periods, representative samples of trucks were weighed and classified by vehicle, body, and fuel type, class of operation, loading status, commodity carried, and axle spacing.

Memmott, Frederick W., Application of Statewide Freight Demand Forecasting Techniques, Roger Creighton Associates, Transportation Research Board, National Cooperative Highway Research Program Report 260, September 1983.

This report presents a customized freight demand forecasting technique which can be used by state transportation agencies to (1) develop current or future estimates of freight flow by highway, rail, and water; (2) forecast freight volume shifts among modes; and (3) provide origins and destinations by commodity within a corridor or region at the intrastate or multistate level. A user manual and three state-level examples are provided.

Motor Vehicle Size and Weight Standards, Western Regional Objectives, Executive Summary, A Study for the TRED (Transportation-Research- Education-Development) Foundation, Western Highway Institute, San Bruno, California, July 1980.

The lack of uniformity in regional motor vehicle size and weight standards is shown to be related to regional, geographic, demographic, and economic differences. The study discusses in detail the size and weight objectives of the trucking industry in the western region; the capacity of today's highways to safely and compatibly accommodate more productive freight trucks operating within recommended standards; the value of such vehicles in relative productivity, operating costs, fuel consumption, and effect on highway pavements and bridges; and experience with more productive vehicles in the western region, including safety of operation.

1982-83 TMTA Membership Handbook and Buyers Guide, Texas Motor Transportation Association, Austin, Texas, 1983.

This handbook identifies the officers, directors, staff, and committee members of TMTA. It describes TMTA's services for members, history, and constitution. A buyers guide to allied and leasing companies arranged by city/state and by classification are included.

The State Department of Highways and Public Transportation Report to the Commission, District 11, Lufkin, Texas, May 27, 1982.

This report gives an overview of economic impacts on District 11 roads and the District staff assigned to maintain them. It includes several maps showing industry and demographic information. Traffic counts of trucks by classification and of passenger cars and motorcycles are also attached.

State Maximum Sizes and Weight Limits for Motor Vehicles, Motor Truck Manufacturers Division, Motor Vehicle Manufacturers Association of the United States, Inc., Washington, D. C., May 1, 1982.

The sizes and weight limits of buses and most truck types are listed by state.

A Study on the Effect of Variations in Truck Weights and Dimensions on Vehicle Stability and Control Characteristics and Pavement Loadings, Final Report, Damas and Smith, a Division of DSL Consultants Ltd., Ontario, Canada, in association with N. D. Lea and Associates Ltd., Vancouver; Highway Safety Research Institute, University of Michigan; A. T. Bergen, University of Saskatchewan; and F. B. Snelgrove, Consultant; July 1982.

This is a feasibility study for a project to begin in 1984 which would measure the stability and control characteristics of heavy truck-trailer configurations under various load conditions and the effects of heavy trucks on pavement response.

"Summary of Size and Weight Limits," *Bulletin Advisory Service*, American Trucking Association, Inc., Washington, D. C., January 1984.

The information contained in these tables is summarized from the *Bulletin Advisory Service* of the American Trucking Association. Size and weight limits of most truck types for each state are detailed in tables, as well as the gross weight allowable under the January 4, 1975, federal weight law formula. Detailed state access provisions and special permit/turnpike/ toll road operations are also included in this summary.

"Texas Moves by Truck and Bus," Texas Motor Transportation Association, Austin, Texas, 1983.

The truck and bus industry's role in the economy of Texas is explained for the public in this pamphlet.

Texas Railroads, Transportation Division, Railroad Commission of Texas, Austin, Texas, 1982.

This map of all Texas railroads identifies railroad routes by company and number. Towns and highway routes are also shown.

This Week in the Legislature, Texas Motor Transportation Association, Austin, No. 9, June 3, 1983.

Recent legislation that effects the state trucking industry is summarized.

Transguide: A Guide to Sources of Freight Transportation Information, Reebie Associates, Greenwich, Connecticut, 1980.

The *Transguide* provides fast access to sources of specialized facts and statistics, as well as background information in most areas of domestic and international freight transportation, including air, pipeline, truck and water transport. It is divided into two cross-referenced sections: (1) sources of information and (2) sponsors and vendors.

Transearch: The Data Base for Freight Transportation, Reebie Associates, Greenwich, Connecticut.

This computerized information service gives updated intercity freight flow data based on actual traffic movements from a number of sources. It offers information on business economic areas, commodities, and various modes of transport, including for-hire and private/exempt trucks.

Trucking and Intermodal Freight Issues, Transportation Research Board, Transportation Research Record 920, Washington, D. C., 1983.

Twelve articles reporting truck and intermodal freight research are in this publication. Included are studies of truck size and weight and a study on the impact of oil field trucks on rural roads.

"U.S. Maps Price List, Effective January 1, 1984," U. S. Geological Survey, Department of the Interior, Reston, Virginia, 1984.

Thematic geological maps and maps by series, area, or scale are listed. There are eastern and western addresses for ordering maps from east and west of the Mississippi, respectively.

Wiggers, George F., Department of Transportation Planning for Bureau of the Census Transportation Surveys, Office of Economics, U. S. Department of Transportation, Washington, D. C., September 1983.

This paper presents an overview of the Department of Transportation's use of Bureau of Census transportation surveys and suggests strategies for sponsoring and taking part in these surveys.

Yu, Chien-pei, and C. Michael Walton, "Characteristics of Double and Triple Trailer Truck Combinations Operating in the United States," prepared for presentation at the 63rd Annual Meeting of the Transportation Research Board, Center for Transportation Research Bureau of Engineering Research, University of Texas, Austin, Texas, January 1984.

This paper describes and evaluates the characteristics of multi-trailer truck combinations found in the two major data bases of the nation's truck resources, the Truck Inventory and Use Survey and the Truck Weight Study. It suggests that some modifications may need to be made to both databases, especially for double and triple truck combinations.

7.2 Computer Program--Pavement Damage Caused by Special-Use Activities

505D 8893

W341TT01

```
********  JES3 JOB SUMMARY  *********
*                                   *
*       2,399 CARDS READ (INTRDR)   *
*                                   *
*       2,392 LINES SPOOLED         *
*                                   *
*           0 CARDS SPOOLED         *
*                                   *
*                                   *
*************************************
```



```
*****  WRITER CHARACTERISTICS  ******
*                                   *
*  DEVICE= XEROX1     TRAIN= PN     *
*                                   *
*  FORMS=  1111       FCB=   8      *
*                                   *
*  SYSOUT= A          JDE=   JFMT6  *
*                                   *
*                                   *
*************************************
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*************************************
*                                   *
*       TEXAS A&M UNIVERSITY        *
*    COMPUTING SERVICES CENTER      *
*                                   *
*   AMDAHL 5850/470V8  MVS/SP/JES3  *
*                                   *
*    17.35.28        9 JAN 85.009   *
*                                   *
*************************************
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WYL LIST 0

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//W341TT01 JOB (W341,505D,S2,5,TT),'WYL/LIST OFFLINE',MSGCLASS=Z
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//TIMBER JOB (W341,505A,S2,3,TT),'CUTTING SITE'
//*XBM WATFIV
C
C        ***********************************************
C
C          TTI  SPECIAL USE TRUCK TRAFFIC DAMAGE PROGRAM
C
C               PROJECT 2-8-81-299  & PROJECT 2-8-83-420
C
C        ***********************************************
C
C          AUTHOR :     T. SCULLION
C                       TEXAS TRANSPORTATION INSTITUTE
C                       TEXAS A&M UNIVERSITY
C                       COLLEGE STATION, TEXAS  77843
C
C              PHONE:  (409) 845-9910
C
C         REVISION BY:  KAY F. SIMMONS
C
C                        REVISIONS WERE DONE IN THE SPRING 1984 FOR
C                        "SPECIAL-USE TRUCK TRAFFIC", PROJECT 2420.
C
C        *********************************************************
C
C
C
C          THIS PROGRAM CALCULATES FOR ANY SURFACE TREATED
C          PAVEMENT:
C
C            A)  THE LIFE TO FAILURE UNDER BASELINE TRAFFIC
C            B)  THE LIFE TO FAILURE UNDER BASELINE + INDUSTRY TRAFFIC
C
C          NOTE THE FOLLOWING :
C
C             1) THE PROGRAM HAS BEEN DEVELOPED FOR SURFACE TREATED
C                PAVEMENTS WITH ADT LT 1000, AND 5 - 15 % TRUCKS
C
C             2) THE CALCULATION OF 18K-ESAL IS DESCRIBED IN TTI
C                RESEARCH REPORT 299-1 OF SDHPT STUDY 2-8-81-299
C
C             3) THE PAVEMENT PERFORMANCE MODELS WHERE DEVELOPED
C                FROM THE TTI FLEXIBLE DATA BASE.
C                  S SHAPED CURVES FOR AREA AND SEVERITY OF EACH
C                  DISTRESS TYPE AND PSI WERE DEVELOPED
C
C                   EG.
C                     DISTRESS = EXP( RHO/N18 ) ** BETA
C
C                   WHERE DISTRESS RANGE = 000 TO 100
C                         RHO AND BETA ARE REGRESSION COEFFICIENTS
C
C                      RHO = F ( RAINFALL,PI,LL,LAYER THICKNESS,....)
C
C              4) PAVEMENT SCORE IS AS DEFINED IN SDHPT PROJECT 2239
C                 TO BE A FUNCTION OF PSI, VISUAL SCORE AND
C                 MAINTENANCE COST
C
C                    PAVE SCORE = F ( PSI, VISUAL, MAINT COST )
C
C                 THIS IS A MULTIPLICATIVE UTILITY APPROACH WHERE:
C
C                    PSI = UTILITY VALUE OF PSI
C                    VISUAL = UTILITY VALUE OF DISTRESS TYPES
C                    MAINT COST = UTILITY VALUE OF MAINTENANCE COST
C                                 IT IS A FUNCTION OF AREA OF PATCHING
C
C               5) PAVEMENT FAILURE IS DEFINED TO OCCUR WHEN PAVEMENT
C                  SCORE FALLS TO AN INPUTTED LEVEL
C
C
C
C
C
C
C      ****************************************************************
C
C
C
```

```
C              INPUT FILES :
C
C                 THE PROGRAM READS DATA APPENDED TO THE END OF THIS
C                 PROGRAM, AS FOLLOWS:
C                     DATA1 : ENVIRONMENTAL DATA, FOLLOWED BY
C                     DATA2 : USER SUPPLIED PAVEMENT, INDUSTRY & RUN DATA
C
C
C              DATA1 :  HAS STORED FOR EACH OF THE 254 TEXAS COUNTIES
C                       1) TIN(I)  THORNTWAITE INDEX
C                       2) RAIN(I) AVERAGE RAINFALL
C                       3) FRTH(I) AIR FREEZE THAW CYCLES
C                       4) AVTP(I) AVERAGE MAX TEMPERATURE
C
C
C              DATA2 :  USER SUPPLIES THE FOLLOWING
C
C                MINSCR    MINIMUM PAVEMENT SCORE
C                DISLIM    MAXIMUM LEVEL OF INDIVIDUAL DISTRESS TYPES
C                          PERMITTED UNTIL FAILURE - NOTE THIS OPTION
C                          IS NOT USED IN CURRENT PROGRAM WHERE FAILURE
C                          IS DEFINED IN TERMS OF PAVEMENT SCORE
C                FAIL      NAMES OF DISTRESS TYPES
C                MON       MONTHS IN WHICH CALCULATIONS ARE TO BE
C                          PERFORMED
C
C
C                CTY       TEXAS COUNTY NUMBER
C
C                FLEXL     THICKNESS OF FLEX BASE IN INCHES
C                DMD       DYNAFLECT MEAN DEFLECTION
C                PI        SUBGRADE PLASTICITY INDEX
C                LL        SUBGRADE LIQUID LIMIT
C
C                ADT       AVERAGE DAILY TRAFFIC ( 2- WAY )
C                PCTTRK    PERCENTAGE TRUCKS
C                GROWTH    PERCENTAGE GROWTH IN ADT
C                PCTLNE    ADT SPLIT
C
C                NDATES    NUMBER OF MONTHS THAT ACTIVITY OCCURED
C                IDATE     MONTH DEVELOPMENT STARTS
C                NWELLS    NUMBER OF WELLS TO BE DRILLED
C
C
C                NSTAT      LOADOMETER STATION INFORMATION TO BE USED
C                          IN THE PROGRAM
C
C                          1  STATION 501--LUBBOCK COUNTY-NORTH BOUND
C                             ON IH 27 NORTH OF LUBBOCK JUST SOUTH OF
C                             FM 1294
C                          2  STATION 502--GUADALUPE COUNTY-WEST BOUND
C                             ON IH 10 WEST OF SEGUIN JUST EAST
C                             OF FM 775 TO LA VERNIA
C                          3  STATION 503--KIMBLE COUNTY-EAST BOUND ON
C                             IH 10 EAST OF JUNCTION JUST NORTH OF
C                             JCT. OF US 84
C                          4  STATION 504--NOLAN COUNTY-WEST BOUND ON
C                             IH 20 WEST OF SWEETWATER JUST EAST OF
C                             JCT. OF US 84
C                          5  STATION 505--NACOGDOCHES COUNTY -SOUTH
C                             BOUND ON US 59 SOUTH OF NACOGDOCHES
C                             APP. 2 MILES NORTH OF ANGELINA RIVER
C                          6  STATION 506--WICHITA COUNTY-WEST BOUND
C                             ON US 287 WEST OF WICHITA FALLS APP. 3
C                             MILES WEST OF IOWA PARK
C                          7  TEXAS--AVERAGE OF THE ABOVE 6 STATIONS
C
C
C                NUSAGE    TYPE OF INDUSTRY
C                          1  OIL FIELD
C                          2  TIMBER MILL
C                          3  TIMBER CUTTING SITE
C
C                PCTIND.   PERCENTAGE OF INDUSTRY'S TRAFFIC IN
C                          DESIGN LANE
C
C                MTYPE     TYPE OF TIMBER MILLS
C                          1  PAPER MILL
C                          2  PLYWOOD
C                          3  PARTICLE BOARD
```

```
C
C                 CHANGE     THE CHANGE IN TIMBER ACTIVITY AT A MILL
C
C                 NACRES     NUMBER OF ACRES HARVESTED IN THE MONTH
C
C                 NCUT       TYPE OF CUT
C                            1  SELECTIVE CUT
C                            2  CLEAR CUT
C
C
C                 ****************************************************
C
C
C
C
C
C
      REAL N18, LL, MTH , N18OIL, N18SER
      REAL*8 FAIL, HEAD
      INTEGER CTY, ENDSCR, ENDMTH
      COMMON   FLEXL, DMD, PI, LL, AVT50, TI50, FTC
      DIMENSION HEAD(10), DIS(20), DISLIM(20),MON(20),FAIL(20), TR(20,4)
      DIMENSION RAIN(254), FRTH(254), TIN(254), AVTP(254), RX(8), V(8)
      DIMENSION TRAF(240,4), IW(60,3), TPER(60)
      DIMENSION DISTSN(10,13),DISTAN(10,16),ESING(13),ETAND(16),
     * PERCNT(10)
C
C     SET PROGRAM SWITCHES
C
      JSW = 0
      NST = 4
      NEN = 3
      NYR = 16
      NDS = 15
      NDSPR = 13
C
C     READ ENVIRONMENTAL DATA FROM DATA1
C
      DO 95  I = 1, 254
   95 READ(5,97) TIN(I), RAIN(I), FRTH(I), AVTP(I)
   97 FORMAT( 7X, G9.3, 2G10.3, 20X, G10.3)
C
C     READ PAVEMENT AND RUN DATA FROM DATA2
C
      READ(5, 98) MINSCR
   98 FORMAT ( I2)
C
      READ(5,100) (DISLIM(I), I = 1, NDSPR )
  100 FORMAT( 16F5.0 )
C
      READ(5,101) (FAIL(I), I = 1, 7 )
  101 FORMAT( 10A8   )
C
      READ(5,102) CTY, FLEXL, DMD, PI, LL
  102 FORMAT( I3,4F10.2 )
      RFAL   =  RAIN(CTY) * 12.0
      AVT    =  AVTP(CTY)
      TI     =  TIN(CTY)
      FTC    =  FRTH(CTY) * 12.0
C
      READ(5,108) (MON(I), I = 1, NYR )
  108 FORMAT( 16I5   )
C
      READ(5,104) (HEAD(I), I = 1, 10 )
  104 FORMAT( 10A8   )
C
   10 READ(5,106,END=50) ADT, PCTTRK, GROWTH, PCTLNE
  106 FORMAT( F8.0, 3(F5.1))
C
C     ***********************************************************
C     TRAFFIC ANALYSIS IS PERFORMED BY THE FOLLOWING SUBROUTINES
C     TRAFIC :  RETURNS 18K ESAL PER MONTH CALCULATION BASED ON
C               W - TABLES DATA AS DESCRIBED IN RESEARCH REPORT
C               299-1 OF PROJECT 2-8-81-299
C     SETTAB  :  THIS ROUTINE LOADS THE ACCUMULATIVE ADT AND N18
C                FOR 240 MONTHS INTO A 240 X 4 ARRAY. NOTE OILFIELD
C                TRAFFIC WILL BE ADDED TO COLS 2 AND 4 IN SUBROUTINE
C                ADDOIL
C     OILDEV :  RETURNS 18K ESAL AND ADT PER MONTH ASSOCIATED
C               WITH OILFIELD DEVELOPMENT
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C      OILSER :  RETURNS 18K ESAL AND ADT PER MONTH ASSOCIATED
C                WITH OILFIELD SERVICING
C      ADDOIL :  THIS ROUTINE ADDS OILFIELD DEVELOPMENT AND SERVICING
C                ADT AND N18 TO THE TRAF ARRAY
C      CONVER :  RETURNS THE 15 X 4 ARRAY TR WHICH CONTAINS THE
C                ADT AND 18K ESAL UNDER OILFIELD AND NORMAL
C                TRAFFIC FOR EACH MONTH CHOSEN IN THE PLANNING
C                HORIZON , SPECIFIED IN MON(I) ARRAY
C      TINDUS :  RETURNS THE COMPLETED TRAF ARRAY FOR A MILL TO THE
C                MAIN PROGRAM
C      SITE :    RETURNS THE COMPLETED TRAF ARRAY FOR A CUTTING SITE
C                TO THE MAIN PROGRAM
C      CUT :     RETURNS 18 ESAL AND ADT PER MONTH ASSOCIATED WITH
C                A CUTTING SITE
C      MILL :    RETURNS 18 ESAL AND ADT PER MONTH ASSOCIATED WITH
C                A MILL
C      ADDCUT :  THIS ROUTINE ADDS CUTTING SITE ADT AND N18 TO THE
C                TRAF ARRAY
C      ADDMIL :  THIS ROUTINE ADDS MILL ADT AND N18 TO THE TRAF ARRAY
C
C
C
C      ***********************************************************
       READ (5,490) NSTAT
   490 FORMAT (I1)
       CALL LOAD (NSTAT,DISTSN,DISTAN,ESING,ETAND,PERCNT)
       CALL TRAFIC ( ADT, PCTTRK, PCTLNE, N18, NSTAT, DISTSN, DISTAN,
      * ESING, ETAND, PERCNT )
       CALL SETTAB ( N18, ADT, GROWTH, TRAF )
       READ (5,500) NUSAGE
       READ(5,510) PCTIND
   510 FORMAT (F5.1)
   500 FORMAT (I1)
C
C      SELECT TYPE OF INDUSTRY
C
       IF (NUSAGE .EQ. 1) GO TO 800
       IF (NUSAGE .EQ. 2) GO TO 850
       IF (NUSAGE .EQ. 3) GO TO 860
   850 CONTINUE
       CALL TINDUS ( NSTAT, NDATES, IW, TPER, MTYPE, TRAF, DISTSN,
      * DISTAN, ESING, ETAND, PCTIND )
       GO TO 810
C
C
   860 CONTINUE
       CALL SITE(NSTAT,DISTSN,DISTAN,ESING,ETAND,NDATES,IW,
      * MTYPE,TRAF,PCTIND)
       GO TO 810
C
C
   800 CALL OILDEV ( NSTAT,N18OIL,ADTOIL,DISTSN,DISTAN,ESING,ETAND )
       CALL OILSER ( NSTAT, N18SER, ADTSER, ESING, ETAND)
       READ ( 5, 107 ) NDATES
   107 FORMAT ( I3)
       DO 110 I = 1, NDATES
       READ ( 5, 109 , END=760 ) IDATE , NWELLS
   109 FORMAT ( I3, 1X, I3)
       IW(I,1) = IDATE
       IW(I,2) = NWELLS
       CALL ADDOIL ( IDATE, NWELLS, N18OIL, ADTOIL, N18SER, ADTSER,
      1                 TRAF )
   110 CONTINUE
C
C
   810 CONTINUE
       CALL CONVER ( MON , NYR, TRAF, TR )
C
C      WRITE OUT INPUT DATA AND HEADINGS
C
       WRITE(6,200) (HEAD(I), I = 1, 10  )
   200 FORMAT( '1', T26, 10A8, // )
C
       WRITE(6,202) FLEXL, DMD, PI, LL
   202 FORMAT( T26, 'STRUCTURAL VARIABLES' // T26,
      1 'FLEXIBLE LAYER THICKNESS', T60, F7.2 / T26,
      2 'W1, MEAN DEFLECTION', T60, F7.2 / T26,
      3 'SUBGRADE PLASTICITY INDEX', T60, F7.2 / T26,
      4 'SUBGRADE LIQUID LIMIT', T60, F7.2  /)
C
```

```
      WRITE(6,204) CTY, AVT, TI, FTC
  204 FORMAT( T26, 'ENVIRONMENTAL VARIABLES FOR COUNTY ', I3, // T26,
     1 'MEAN TEMPERATURE', T60, F7.2 / T26,
     2 'THORNTWAITE INDEX', T60, F7.2 / T26,
     3 'FREEZE /THAW CYCLES', T60, F7.2 /)
C
      WRITE(6,206) (DISLIM(I), I = 1, NDSPR )
  206 FORMAT(T26,'DISTRESS LIMITS  AREA  SEV.' // T26, 'PSI', T47,F6.1,
     1/T26, 'RUTTING', T41, 2F6.1 / T26, 'RAVELING', T41, 2F6.1 / T26,
     2 'FLUSHING', T41, 2F6.1 / T26, 'ALLIGTR + PATCH', T41, 2F6.1 /
     3T26,'LONGITUD CRK', T41,2F6.1 /T26, 'TRANSVERSE CRK',
     5 T41, 2F6.1 /)
C
      WRITE ( 6, 205) MINSCR
  205 FORMAT ( T26,'** MINIMUM PAVEMENT SCORE ALLOWED = ',I2,' **', //)
C
C
      WRITE(6,208) N18, ADT, PCTTRK, GROWTH
  208 FORMAT ( T26, 'TRAFFIC ANALYSIS DATA', /,
     1          T26, '*********************',/,
     4         T26, 'BASELINE CONDITION',//,
     2         T26, 'N18/MTH = ', F5.0, '    ADT/LANE = ', F5.0 , /,
     3         T26, '% TRUCKS = ', F5.2 , '   % GROWTH = ', F5.2, /)
C
      WRITE (6,279) PCTIND
  279 FORMAT ( T26, 'INDUSTRY CONDITION',/,
     1 T26,'PERCENT INDUSTRY TRAFFIC IN DESIGN LANE = ',F5.1,' %',/)
      WRITE ( 6, 60)
      DO 70  I = 1, NYR
      WRITE ( 6, 80) MON(I), TR(I,1), TR(I,2), TR(I,3), TR(I,4)
   70 CONTINUE
      WRITE (6,84)
      WRITE (6,85)
   60 FORMAT ( /, 30X, 'MONTH   ADT(B)   ADT(I)   N18(B)   N18(I)')
   80 FORMAT ( 30X, I3, 3X, F9.0 , F9.0, 2(1X, F8.0))
   84 FORMAT(/,40X,' B = BASELINE CONDITION')
   85 FORMAT(40X,' I = BASELINE + INDUSTRY CONDITION')
C
C     THE FIRST TIME THRU INITIALIZE THE FOLLOWING
C
      IF( JSW .GT. 0 ) GO TO 12
      JSW = JSW + 1
      AVT50 = AVT - 50.
      TI50 = TI + 50.
      AKIP = 1.0
      CALL FINDRF ( RFAL, FTC, V)
      CALL FINDA1 ( ADT, AKIP, A1)
   12 CONTINUE
C
C
C         ***************************************************
C         THIS IS THE MAIN CALCULATION LOOP OF THE PROGRAM
C
C         J = 1  INTENDED USE TRAFFIC
C         J = 2  INTENDED + OILFIELD TRAFFIC
C
C         *****************************************************
C
      DO 26 J = 1, 2
      IF ( J .EQ. 1 ) WRITE ( 6, 299)
      IF ( J .EQ. 2 ) WRITE ( 6, 300)
      IFAIL = 0
      IPES  = 100
C
      WRITE(6,215)
  215 FORMAT( T16, 'RUTTING     RAVELING   FLUSHING    ALLIGATOR ',
     1'  LONGITUDNL  TRANSVERSE  PATCHING      PAVEMENT  SCORE (PES)'
     2  / T3, 'MONTH  RIDE  AREA  SEV.  AREA  SEV.  AREA  SEV.   ',
     3 'AREA  SEV.  AREA  SEV.  AREA  SEV.  AREA  SEV.' ,
     4 '    VISUAL   PSI    MCOST   TOTAL')
C
C
C           NORMALLY NYR = 12 THIS BEING NUMBER OF DATES AT
C           WHICH THE PAVEMENT SCORE IS TO BE CALCULATED.
C           THE ACTUAL MONTHS ARE STORED IN MON(NYR) = 1, 6, ...
C           FOR EACH OF THESE MONTHS THE ACC. ADT AND N18 ARE
C          INPUT INTO THE DAMAGE SUBROUTINE WHICH RETURNS
C          PAVEMENT CONDITION IN TERMS OF AREA AND SEVERITY
C          OF EACH DISTRESS TYPE AND PSI
C
```

```
C
C
      DO 25 I = 1, NYR
      INPES  = IPES
      ADT = TR( I, J) / 1000000.
      N18 = TR( I, J+2) / 1000000.
      MTH = MON(I)
C
      CALL DAMAGE( N18, ADT, MTH, DIS )
C
      DO 14 L = 2, NDS
   14 DIS(L) = DIS(L) * 100.0
C
C        THE DIS ARRAY CONTAINS THE AREA AND SEVERITY VALUES
C        THESE VALUES AREA NOW PRE PROCESSED BEFORE
C        ENTRY INTO THE RAMS STATE COST ESTIMATING PAVEMENT
C        SCORE CALCULATION ROUTINES.
C
C        NOTE AREA OF DISTRESS IS ONLY USED WHEN THE SEVERITY
C        VALUE EXCEEDS 10.0 PERCENT
C
C        THE UTILITY SUBROUTINES ARE TAKEN FROM THE STATES PES
C        SYSTEM PROJECT 2239
C
C
      ADTS = ADT * 55.0
      SRCE = DIS(1)
      DO 135  N = 1, 8
      RX(N) = 0.0
  135 CONTINUE
      IF ( DIS(3) .LT. 0.15 ) GOTO 140
      RX(1)  = 0.0
      RX(2)  = DIS(2)
      GOTO 150
  140 RX(1) = DIS(2)
      RX(2) = 0.0
  150 CONTINUE
      IF ( DIS(5) .GT. 10.0) RX(3) = DIS(4)
      IF ( DIS(7) .GT. 10.0) RX(4) = DIS(6)
      IF ( DIS(9) .GT. 10.0) RX(6) = DIS(8)
      IF ( DIS(11) .GT. 10.0) RX(7) = DIS(10)
      IF ( DIS(13) .GT. 10.0) RX(8) = DIS(12)
      PATCH = DIS(14)
      CALL UTLTY1 ( RX, V, AVUC)
      CALL UTLTY2 ( ADTS, SRCE, SIUC)
      CALL UTLTY4 ( PATCH, RMUC)
      A2  = 1.0
      A4  = 1.0
      PESC  = AVUC ** A1 * SIUC **A2 * RMUC **A4
      IPES  = INT(PESC * 100.)
      IAVU  = INT(AVUC * 100.)
      ISIU  = INT(SIUC * 100.)
      IRMC  = INT(RMUC * 100.)
C
   22 WRITE(6,220) MON(I), (DIS(L), L = 1, NDS ), IAVU, ISIU, IRMC,IPES
  220 FORMAT( /, T2, I4, F8.2, 14F6.1, 4(4X, I3) )
C
      IF (IPES .GT. MINSCR ) GOTO 25
      IF (IFAIL.GT. 0 )  GOTO 25
      IFAIL = 1
      INSCR = INPES
      ENDSCR = IPES
      INMTH = MON(I-1)
      ENDMTH = MON(I)
   25 CONTINUE
      IF ( IFAIL .EQ. 0 ) GOTO 99
      IDIF = INSCR - ENDSCR
      IREQ = INSCR - MINSCR
      IMTH = ENDMTH - INMTH
      RABC = FLOAT(IREQ) / FLOAT(IDIF)
      REQ  = INMTH + RABC * IMTH
      IF ( J .EQ. 1) WRITE (6, 301) REQ
      IF ( J .EQ. 2) WRITE(6,302) REQ
      GOTO 26
   99 IF ( J .EQ. 1) WRITE (6, 303)
      IF ( J .EQ. 2) WRITE ( 6, 304)
   26 CONTINUE
      IF (NUSAGE.EQ.1) GO TO 610
      IF (NUSAGE.EQ.2) GO TO 620
      IF (NUSAGE.EQ.3) GO TO 630
```

```
  610 WRITE (6,710) ((IW(I,M), M=1,2),I=1,NDATES)
      GO TO 10
  620 CONTINUE
      IF (MTYPE.EQ.1) WRITE (6,720)
      IF (MTYPE.EQ.2) WRITE (6,721)
      IF (MTYPE.EQ.3) WRITE (6,722)
      WRITE (6,724)
      DO 598 K=1, NDATES
      WRITE(6,725) IW(K,1), TPER(K)
  598 CONTINUE
      GO TO 10
  630 WRITE (6,730)
      DO 599 K=1, NDATES
      WRITE(6,731) IW(K,1),IW(K,2),IW(K,3)
  599 CONTINUE
      WRITE(6,781)
  781 FORMAT(///,40X,' TYPE CUT 1 = SELECTIVE CUT ',
     *  /,40X,' TYPE CUT 2 = CLEAR CUT ')
      GO TO 10
  710 FORMAT (1H1,////,10X,'INDUSTRY DEVELOPMENT      MONTH ',
     *   '   NO. WELLS ', /, 15(40X,I3,10X,I3,/))
  720 FORMAT(1H1,////,10X,' PAPER MILL')
  721 FORMAT(1H1,////,10X,' PLYWOOD MILL')
  722 FORMAT(1H1,////,10X,' PARTICLE BOARD MILL')
  724 FORMAT(//,35X,' MONTH     RATE OF INCREASE',/// )
  725 FORMAT(40X,I3,10X,F4.2)
  730 FORMAT(1H1,////,45X,' INDUSTRY DEVELOPMENT',//,40X,' MONTH ',
     *   '   NO. ACRES      TYPE CUT ',/// )
  731 FORMAT(40X,I3,10X,I3,10X,I1,/ )
C
C
   50 WRITE(6,250)
  250 FORMAT( '1' )
  299 FORMAT ( 1H1, ////, T20, 'PAVEMENT DESIGN PROGRAM ---- ',
     1          'BASELINE TRAFFIC', //// )
  300 FORMAT ( 1H1, ////, T20, 'PAVEMENT DESIGN PROGRAM ---- ',
     1           'BASELINE PLUS FUTURE INDUSTRY TRAFFIC',////)
  301 FORMAT ( /////, 10X, 'TIME TO FAILURE UNDER BASELINE TRAFFIC',
     1          20X, '=  ', F5.1, ' MTHS' )
  302 FORMAT ( ///, 10X, 'TIME TO FAILURE UNDER BASELINE + ',
     *          ' INDUSTRY TRAFFIC    =', F5.1, ' MTHS',// )
  303 FORMAT (///,10X,'SECTION DID NOT FAIL UNDER BASELINE TRAFFIC',
     1                     ' IN ANALYSIS PERIOD')
  304 FORMAT ( ///, 10X, 'SECTION DID NOT FAIL UNDER NORMAL PLUS ',
     1                    'OILFIELD TRAFFIC IN ANALYSIS PERIOD')
      GOTO 900
  760 WRITE ( 6, 770)
  770 FORMAT ( 1H1, ' ERROR IN INPUT DATA', /
     1          10X, ' NUMBER OF INPUT DATES DOES NOT MATCH ACTUAL NO.')
  900 CONTINUE
      STOP
      END
C
C
C
C
C
      SUBROUTINE DAMAGE( N18, ADT, MTH, DIS )
C
C       *******************************************************
C       THESE REGRESSION EQUATIONS FOR EACH DISTRESS TYPE WERE
C       DEVELOPED AS PART OF SDHPT RESEARCH PROJECT 2284 USING
C       INSPECTION DATA COLLECTED ON OVER 100 THIN PAVEMENT
C       SECTIONS IN TEXAS.
C
C       NOTE: MAX AND MIN VALUES HAVE BEEN PLACED ON EACH RHO
C             AND BETA VALUE.
C
C
C       *******************************************************
C
      DIMENSION DIS(15)
      REAL N18, LL, MTH
      COMMON   FLEXL, DMD, PI, LL, AVT50, TI50, FTC
C
      P1 = 4.2
      PF = 0.83
C
C    PSI
      RHO = -0.173 + 0.00687*AVT50 - 0.000632*TI50 + 0.0133*FLEXL
```

```
     1 + .00075*LL + .00153*FTC - 0.0214*DMD
C
      IF( RHO .GT. 0.511 )  RHO = 0.511
      IF( RHO .LT. 0.0009 ) RHO = 0.0009
C
      DIS(1) = 4.2
      X      = ( RHO/N18)
      IF ( X .GT. 10.0 ) GOTO 1
      DIS(1) = P1 - (P1 - PF) * EXP( - (X))
    1 CONTINUE
C
C     RUT AREA
      RHO = -0.1035 + 0.00549*AVT50 + 0.0067*FLEXL - 0.0015*LL
     & + 0.00162*PI + 0.00077*FTC
      BETA = 1.540 + 0.0169*TI50 - 0.072*FLEXL
C
      IF( RHO .GT. 0.117 ) RHO = 0.117
      IF( RHO .LT. 0.0036 ) RHO = 0.0036
C
      IF( BETA .GT. 6.27 ) BETA = 6.27
      IF( BETA .LT. 0.615 ) BETA = 0.615
C
      DIS(2) = 0.0
      X      = ( RHO/N18) ** BETA
      IF ( X .GT. 10.0 ) GOTO 2
      DIS(2) = EXP ( -(X))
    2 CONTINUE
C
C     RUT SEV
      RHO = -0.0678 + 0.0032*AVT50 + 0.00566*FLEXL - 0.00031*LL
     & + 0.00048*FTC
      BETA = 1.780
C
      IF( RHO .GT. 0.121 ) RHO = 0.121
      IF( RHO .LT. 0.0027 ) RHO = 0.0027
C
      IF( BETA .GT. 5.94 ) BETA = 5.94
      IF( BETA .LT. 0.527 ) BETA = 0.527
C
      DIS(3) = 0.0
      X      = ( RHO/N18) ** BETA
      IF ( X .GT. 10.0 ) GOTO 3
      DIS(3) = EXP ( -(X))
    3 CONTINUE
C
C     RAV AREA
      RHO = 1.030 + 0.0146*TI50 + 0.0064*FTC - 0.6089*DMD
      BETA = 1.28
C
      IF( RHO .GT. 2.76 ) RHO = 2.76
      IF( RHO .LT. 0.095 ) RHO = 0.095
C
      IF( BETA .GT. 6.1 ) BETA = 6.1
      IF( BETA .LT. 0.52 ) BETA = 0.52
C
      DIS(4) = 0.0
      X      = ( RHO/ADT) ** BETA
      IF ( X .GT. 10.0 ) GOTO 4
      DIS(4) = EXP ( -(X))
    4 CONTINUE
C
C     RAV SEV
C
      RHO = 0.621 + 0.0129*TI50 + 0.0066*FTC - 0.449*DMD
      BETA = 1.40
C
      IF( RHO .GT. 2.8 ) RHO = 2.8
      IF( RHO .LT. 0.077 ) RHO = 0.077
C
      DIS(5) = 0.0
      X      = ( RHO/ADT) ** BETA
      IF ( X .GT. 10.0 ) GOTO 5
      DIS(5) = EXP ( -(X))
    5 CONTINUE
C
C     FLUSH AREA
      RHO = 0.488 + 0.0127*TI50 + 0.00345*FTC - 0.213*DMD
      BETA = 1.27
C
      IF( RHO .GT. 2.84 ) RHO = 2.84
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```
      IF( RHO .LT. 0.062 ) RHO = 0.062
C
      DIS(6) = 0.0
      X      = ( RHO/ADT) ** BETA
      IF ( X .GT. 10.0 ) GOTO 6
      DIS(6) = EXP ( -(X))
    6 CONTINUE
C
C     FLUSH SEV
      RHO = -0.14 + 0.031*AVT50 + 0.0103*TI50 + 0.00541*FTC - 0.201*DMD
      BETA = 1.50
C
      IF( RHO .GT. 2.18 ) RHO = 2.81
      IF( RHO .LT. 0.063 ) RHO = 0.063
C
      IF( BETA .GT. 5.45 ) BETA = 5.45
      IF( BETA .LT. 0.51 ) BETA = 0.51
C
      DIS(7) = 0.0
      X      = ( RHO/ADT) ** BETA
      IF ( X .GT. 10.0 ) GOTO 7
      DIS(7) = EXP ( -(X))
    7 CONTINUE
C
C     ALLIGATOR AREA
C
      RHO = -0.179 + 0.0121*AVT50 + 0.0040*FLEXL - 0.0011*LL
     !  + 0.00153*FTC
      BETA = 1.867 - 0.00908*TI50 + 0.144*FLEXL - 0.572*DMD
C
      IF( RHO .GT. 0.19 ) RHO = 0.19
      IF( RHO .LT. 0.003 ) RHO = 0.003
C
      IF( BETA .GT. 7.29 ) BETA = 7.29
      IF( BETA .LT. 0.51 ) BETA = 0.51
C
C
      DIS(8) = 0.0
      X      = ( RHO/N18) ** BETA
      IF ( X .GT. 10.0 ) GOTO 8
      DIS(8) = EXP ( -(X))
    8 CONTINUE
C
C
C     ALLIGATOR SEV
C
      RHO = -0.2219 + 0.0119*AVT50 + 0.000327*TI50 + 0.00274*FLEXL
     1      - 0.000579*LL + 0.00166*FTC
      BETA = 2.909 + 0.0998*AVT50 + 0.013*LL -1.567*DMD
C
      IF( RHO .GT. 0.07 ) RHO = 0.07
      IF( RHO .LT. 0.003 ) RHO = 0.003
C
      IF( BETA .GT. 9.8 ) BETA = 9.8
      IF( BETA .LT. 0.51 ) BETA = 0.51
C
C
      DIS(9) = 0.0
      X      = ( RHO/N18) ** BETA
      IF ( X .GT. 10.0 ) GOTO 9
      DIS(9) = EXP ( -(X))
    9 CONTINUE
C
C
C     LONG AREA
C
      RHO = -63.1 + 4.52*AVT50 + 0.541*TI50 + 7.41*FLEXL + 1.1145*FTC
      BETA = 1.15
C
      IF( RHO .GT. 172.0 ) RHO = 172.0
      IF( RHO .LT. 30.0 ) RHO = 30.0
C
      IF( BETA .GT. 2.65 ) BETA = 2.65
      IF( BETA .LT. 0.68 ) BETA = 0.68
C
C
      DIS(10) = 0.0
      X      = ( RHO/MTH) ** BETA
      IF ( X .GT. 10.0 ) GOTO 10
      DIS(10) = EXP ( -(X))
```

```
   10 CONTINUE
C
C     LONG SEV
C
      RHO = -120.1 + 6.77*AVT50 + 1.146*TI50 + 4.78*FLEXL + 1.32*FTC
      BETA = 1.58
C
      IF( RHO .GT. 167.0 ) RHO = 167.0
      IF( RHO .LT. 21.0 ) RHO = 21.0
C
C
      DIS(11) = 0.0
      X       = ( RHO/MTH) ** BETA
      IF ( X .GT. 10.0 ) GOTO 11
      DIS(11) = EXP ( -(X))
   11 CONTINUE
C
C     TRANS AREA
C
      RHO = -66.4 + 2.156*TI50 + 10.12*FLEXL + 0.718*FTC
      BETA = 2.059 + 0.0734*FLEXL - 0.06*LL + 0.0607*PI - 0.00375*FTC
      IF( RHO .GT. 176.0 ) RHO = 176.0
      IF( RHO .LT. 41.0 ) RHO = 41.0
C
      IF( BETA .GT. 2.65 ) BETA = 2.65
      IF( BETA .LT. 0.61 ) BETA = 0.61
C
      DIS(12) = 0.0
      X       = ( RHO/MTH) ** BETA
      IF ( X .GT. 10.0 ) GOTO 12
      DIS(12) = EXP ( -(X))
   12 CONTINUE
C
C     TRANS SEV
C
      RHO = 96.3 - 1.04*AVT50 + 1.068*TI50 - 0.318*FTC
      BETA = 1.10 + 0.1606*LL - 0.237*PI -0.0154*FTC
C
      IF( RHO .GT. 173.0 ) RHO = 173.0
      IF( RHO .LT. 33.0 ) RHO = 33.0
C
      IF( BETA .GT. 6.65 ) BETA = 6.65
      IF( BETA .LT. 0.56 ) BETA = 0.56
C
      DIS(13) = 0.0
      X       = ( RHO/MTH) ** BETA
      IF ( X .GT. 10.0 ) GOTO 13
      DIS(13) = EXP ( -(X))
   13 CONTINUE
C
C     PATCHING
C
      RHO = 0.00799 + 0.00252*AVT50 + 0.000218*TI50 + 0.00166*FLEXL
     1      - 0.00125*PI
      BETA = 1.75
C
      IF( RHO .GT. 0.104 ) RHO = 0.104
      IF( RHO .LT. 0.0036 ) RHO = 0.0036
C
      IF( BETA .GT. 5.36 ) BETA = 5.36
      IF( BETA .LT. 0.63 ) BETA = 0.63
C
      DIS(14) = 0.0
      X       = ( RHO/N18) ** BETA
      IF ( X .GT. 10.0 ) GOTO 14
      DIS(14) = EXP ( -(X))
   14 CONTINUE
C
C     PATCH SEV
      RHO = -0.0404 + 0.0035*AVT50 + 0.0029*FLEXL - 0.000424*LL
     & + 0.000389*FTC
      BETA = -0.158 + 0.0504*AVT50 + 0.0897*FLEXL - 0.0687*LL
     1      + 0.0820*PI + 0.0270*FTC
      IF( RHO .GT. 0.090 ) RHO = 0.090
      IF( RHO .LT. 0.0027 ) RHO = 0.0027
C
      IF( BETA .GT. 3.27 ) BETA = 3.27
      IF( BETA .LT. 0.527 ) BETA = 0.527
C
      DIS(15) = 0.0
```

```
            X       = ( RHO/N18) ** BETA
            IF ( X .GT. 10.0 ) GOTO 15
            DIS(15) = EXP ( -(X))
         15 CONTINUE
      C
      C
            RETURN
            END
      C
      C
      C
      C
      C
            SUBROUTINE SETTAB ( N18, ADT, GROWTH, TRAF)
      C
      C     ********************************************************
      C     THIS SUBROUTINE SETS UP A 240 X 4 ARRAY OF TRAFFIC DATA
      C
      C     ONE ROW FOR EACH MONTH IN THE ANALYSIS PERIOD 240 MONTHS
      C     COL 1 IS USED FOR ACC. ADT
      C     COL 2 IS USED FOR ACC. ADT PLUS OILFIELD ADT
      C     COL 3 IS USED FOR ACC. N18
      C     COL 4 IS USED FOR ACC. N18 PLUS OILFIELD N18
      C
      C     NOTE OILFIELD TRAFFIC ADDED IN SUBROUTINE ADDOIL
      C
      C     *********************************************************
      C
            DIMENSION TRAF(240,4)
            REAL N18
            X1   = ADT * 30.
            X3   = N18
            TRAF(1,1) = X1
            TRAF(1,2) = X1
            TRAF(1,3) = X3
            TRAF(1,4) = X3
            DO 50 I = 2, 240
            K = I - 1
            X1 = X1 * ( 1.0 + GROWTH/1200.0 )
            X3 = X3 * ( 1.0 + GROWTH/1200.0 )
            TRAF(I,1)  = TRAF(K,1) + X1
            TRAF(I,2)  = TRAF(I,1)
            TRAF(I,3)  = TRAF(K,3) + X3
            TRAF(I,4)  = TRAF(I,3)
         50 CONTINUE
      C      WRITE ( 6, 69)
      C  69 FORMAT( 1H1, 10X, 'I', ' TRAF1  TRAF2   TRAF3  TRAF4 ' )
      C     DO 60 I = 1, 240, 12
      C     WRITE ( 6, 70) I, (TRAF(I,J), J=1,4)
      C 70  FORMAT ( 10X, I3, 4F9.0 )
         60 CONTINUE
            RETURN
            END
      C
      C
      C
      C
      C
            SUBROUTINE ADDOIL ( IDATE, NWELLS, N18OIL, ADTOIL, N18SER,
          1                      ADTSER, TRAF )
      C
      C      *********************************************************
      C
      C      THIS SUBROUTINE ADDS THE OILFIELD DEVELOPMENT AND SERVICING
      C      TRAFFIC TO THE TRAF ARRAY. COLUMN 2 HAS THE ADT DATA COLUMN 4
      C      CONTAINS THE N18 DATA.
      C
      C      *********************************************************
      C
            DIMENSION TRAF(240,4), ASER(240), BSER(240)
            REAL N18OIL, N18SER
            X1   = ADTOIL * 30.0
            X2   = ADTSER * 30.0
            X3   = N18OIL
            X4   = N18SER
            DO 10  I = IDATE, 240
            TRAF(I,2) = TRAF(I,2) + NWELLS*X1
            TRAF(I,4) = TRAF(I,4) + NWELLS*X3
         10 CONTINUE
      C
```

```
C      ADD ON SECOND MONTHS OIL DEVELOPMENT TRAFFIC
C
      L = IDATE + 1
      DO 20 I = L , 240
      TRAF(I,2) = TRAF(I,2) + NWELLS*X1
      TRAF(I,4) = TRAF(I,4) + NWELLS*X3
   20 CONTINUE
C
C             OILFIELD SERVICING TRAFFIC DECREASING 50% EACH YEAR
C
      L = IDATE + 2
      LEFT = 240 - L + 1
      DO 30  I = 1, LEFT
      ASER(I) = X2 * NWELLS
      BSER(I) = X4 * NWELLS
      IF ( MOD(I,12) .NE. 0 ) GOTO 25
C     WRITE ( 6, 24 ) I, X2, X4
C 24  FORMAT ( 10X, I3, 2F9.0 )
      X2 = X2 / 2.0
      X4 = X4 / 2.0
   25 CONTINUE
   30 CONTINUE
C
      DO 35 J = 2, LEFT
      ASER(J) = ASER(J-1) + ASER(J)
   35 BSER(J) = BSER(J-1) + BSER(J)
C
C     WRITE ( 6, 59)
C  59 FORMAT ( 1H1, 10X, 'I', 10X, 'ASER', 10X, 'BSER',/)
C     DO 50 I = 1, LEFT, 12
C 50  WRITE ( 6, 60) I, ASER(I), BSER(I)
C  60 FORMAT(  9X, I3, 5X, F9.0, 5X, F9.0)
C
C
      DO 40 I = L, 240
      K = I - L + 1
      TRAF(I,2) = TRAF(I,2) + ASER(K)
      TRAF(I,4) = TRAF(I,4) + BSER(K)
   40 CONTINUE
C
      RETURN
      END
C
C
C
C
C
      SUBROUTINE CONVER ( MON, NYR, TRAF, TR)
C
C      *******************************************************
C      THIS SUBROUTINE LOADS THE TR ARRAY WITH TRAFFIC DATA FOR
C      THE SELECTED REPORTING MONTHS STORED IN MON(20)
C      *******************************************************
C
      DIMENSION  MON(20), TRAF(240, 4), TR(20, 4)
      DO 10 I = 1, NYR
      TR(I,1) = TRAF(MON(I),1)
      TR(I,2) = TRAF(MON(I),2)
      TR(I,3) = TRAF(MON(I),3)
      TR(I,4) = TRAF(MON(I),4)
   10 CONTINUE
      RETURN
      END
C
C
C
C
C
      SUBROUTINE TRAFIC ( ADT, PCTTRK, PCTLNE, N18, NSTAT, DISTSN,
     * DISTAN, ESING, ETAND, PERCNT )
C
C     ***********************************************************
C
C     THIS SUBROUTINE CALCULATES THE NUMBER OF 18 KIP SINGLE AXLE
C     ASSOCIATED WITH THE ADT , PERCENTAGE TRUCKS AND PERCENTAGE
C     VEHICLES IN DESIGN LANE.
C
C
C     DETAILS OF THE CALCULATION ARE IN REPORT 299-1
C
```

```
C      SINGLE - CONTAINS THE NUMBER OF SINGLE AXLES BY TRUCK TYPE
C      TANDEM - CONTAINS THE NUMBER OF TANDEM AXLES BY TRUCK TYPE
C
C      **********************************************************
C
       REAL N18, NSING, NTAND, NSINGL, NTANDM,N18SIN, N18TAN, NTRUKS
C
       DIMENSION DISTSN(10,13), DISTAN(10,16),ESING(13),ETAND(16),
     + NSING(13), NTAND(16), NSINGL(10), NTANDM(10), PERCNT(10),
     * SINGLE(10), TANDEM(10), TTYPE(10)
C
C
C
C
C
C
       DATA SINGLE / 2.0,1.0,3.0,2.0,1.0,5.0,2.0,3.0,2.0,1.0 /
       DATA TANDEM /0.0,1.0,0.0,1.0,2.0,0.0,2.0,0.0,1.0,2.0 /
C
C
C
       NTYP = 10
C
C
C
       ADT = ADT * (PCTLNE/100.0)
       NTRUKS = ADT * 365.0 * (PCTTRK/100.0)
C
       DO 10 I = 1, NTYP
       TTYPE(I) = PERCNT(I) * NTRUKS * 0.01
       NSINGL(I) = TTYPE(I) * SINGLE(I)
       NTANDM(I) = TTYPE(I) * TANDEM(I)
    10 CONTINUE
C
C
       DO 14 J = 1, 13
    14 NSING(J) = 0.0
C
       DO 15 J = 1, 16
    15 NTAND(J) = 0.0
C
C
       DO 30 K = 1, 10
       DO 20 J = 1, 13
    20 NSING(J) = NSING(J) + NSINGL(K)*DISTSN(K,J)/100.0
    30 CONTINUE
C
C
       DO 50 K = 1, 10
       DO 40 J = 1, 16
    40 NTAND(J) = NTAND(J) + NTANDM(K)*DISTAN(K,J)/100.0
    50 CONTINUE
C
C
       N18SIN = 0.0
C
       DO 60 J = 1, 13
    60 N18SIN = N18SIN + NSING(J) * ESING(J)
C
C
       N18TAN = 0.0
       DO 70 J = 1, 16
    70 N18TAN = N18TAN + NTAND(J) * ETAND(J)
C
       N18 = N18SIN + N18TAN
C
C      WRITE(6,250) ADT, PCTTRK, PCTLNE, N18
C 250  FORMAT( 1H1, 10X, 'SUBROUTINE TRAFIC', /,2X, 'ADT = ', F7.1, 2X,
C    + 'PCT TRUCKS = ', F5.1, 2X,'PCT SPLIT = ', F7.1, 2X,
C    = 'N18 = ', G14.5  /////  )
C
C      WRITE(6,255) N18SIN, N18TAN
C 255  FORMAT( 2X, 'N18 SINGLE = ', F10.3, 2X, 'N18 TANDEM = ', F10.3 //)
C      RETURN
C      END
C
C      WRITE(6,260) (NSING(I), I = 1, 13)
C 260  FORMAT( ' NSING = ', 13F8.1 // )
C      WRITE(6,262) (NTAND(I), I = 1, 16 )
C 262  FORMAT( ' NTAND = ', 13F8.1 // 9X, 3F8.1 // )
```

```
C
      N18 = N18 / 12.0
      RETURN
      END
C
C
C
C
C
      SUBROUTINE OILDEV (NSTAT,N18OIL,ADTOIL,DISTSN,DISTAN,ESING,
     * ETAND)
C
C       ****************************************************
C       THIS SUBROUTINE RETURNS THE 18 KIP ESAL (N18OIL) AND
C        ADT (ADTOIL) ASSOCIATED WITH OILFIELD DEVELOPMENT WORK
C
C        TTYPE - CONTAINS THE NUMBER OF EACH TRUCK TYPE COUNTED AT
C                THE ENTRANCE TO A DRILLING SITE OVER A 60 DAY
C                OILWELL DEVELOPMENT PERIOD.
C
C       ********************************************************
C
      REAL N18, NSING, NTAND, NSINGL, NTANDM,N18SIN, N18TAN
      REAL N18OIL
C
      DIMENSION DISTSN(10,13), DISTAN(10,16), ESING(13), ETAND(16),
     + NSING(13), NTAND(16), NSINGL(10), NTANDM(10),
     * SINGLE(10), TANDEM(10), TTYPE(10)
C
C
C
C
C
      DATA SINGLE / 2.0,1.0,3.0,2.0,1.0,5.0,2.0,3.0,2.0,1.0 /
      DATA TANDEM /0.0,1.0,0.0,1.0,2.0,0.0,2.0,0.0,1.0,2.0 /
C
      DATA TTYPE / 300.0,150.0,45.0,0.0,655.0,0.0,0.0,90.0,0.0,
     + 125.0 /
C
C
      NTYP = 10
      ADTOIL = 150.0
C
C
C
C
      DO 10 I = 1, NTYP
      NSINGL(I) = TTYPE(I) * SINGLE(I)
      NTANDM(I) = TTYPE(I) * TANDEM(I)
   10 CONTINUE
C
C
      DO 14 J = 1, 13
   14 NSING(J) = 0.0
C
      DO 15 J = 1, 16
   15 NTAND(J) = 0.0
C
C
      DO 30 K = 1, 10
      DO 20 J = 1, 13
   20 NSING(J) = NSING(J) + NSINGL(K)*DISTSN(K,J)/100.0
   30 CONTINUE
C
C
      DO 50 K = 1, 10
      DO 40 J = 1, 16
   40 NTAND(J) = NTAND(J) + NTANDM(K)*DISTAN(K,J)/100.0
   50 CONTINUE
C
C
      N18SIN = 0.0
C
      DO 60 J = 1, 13
   60 N18SIN = N18SIN + NSING(J) * ESING(J)
C
C
      N18TAN = 0.0
      DO 70 J = 1, 16
   70 N18TAN = N18TAN + NTAND(J) * ETAND(J)
```

```
C
      N18 = N18SIN + N18TAN
C
      N18OIL = N18 / 2.0
C
      WRITE(6,250) N18OIL, ADTOIL
  250 FORMAT( //2X, 'N18OIL = ', F10.3, 2X, 'ADTOIL = ', F6.1,//)
      WRITE(6,260) (NSING(I), I = 1, 13)
  260 FORMAT( ' NSING = ', 13F8.1 // )
      WRITE(6,262) (NTAND(I), I = 1, 16 )
  262 FORMAT( ' NTAND = ', 13F8.1 // 9X, 3F8.1 // )
      N18OIL = N18OIL / 2.0
C
      RETURN
      END
C
C
C
C
C
C
      SUBROUTINE OILSER ( NSTAT, N18SER, ADTSER, ESING, ETAND )
C
C      ************************************************************
C
C      THIS SUBROUNTINE RETURNS THE NUMBER OF 18KIP ESAL AND ADT
C      IN DESIGN LANE ASSOCIATED WITH OILFIELD SERVICING.
C
C      ************************************************************
C
C
      REAL N18, NSING, NTAND, N18SIN, N18TAN
      REAL N18SER
C
      DIMENSION SDISTR(13), TDISTR(16), ESING(13), ETAND(16),
     + NSING(13), NTAND(16)
C
C
C
C
      DATA SDISTR / 0.0, 0.5, 0.0, 0.5, 9*0.0 /
C
      DATA TDISTR / 0.0, 1.0, 5*0.0, 1.0, 8*0.0 /
C
C
      ADTSER = 50.0
      SRVICE = 150.0
C
      DO 14 J = 1, 13
   14 NSING(J) = 0.0
C
      DO 15 J = 1, 16
   15 NTAND(J) = 0.0
C
C
      DO 20 J = 1, 13
   20 NSING(J) = SRVICE * SDISTR(J)
C
C
      DO 40 J = 1, 16
   40 NTAND(J) = SRVICE * TDISTR(J)
C
C
      N18SIN = 0.0
C
      DO 60 J = 1, 13
   60 N18SIN = N18SIN + NSING(J) * ESING(J)
C
C
      N18TAN = 0.0
      DO 70 J = 1, 16
   70 N18TAN = N18TAN + NTAND(J) * ETAND(J)
C
      N18 = N18SIN + N18TAN
C
      N18SER = N18 / 2.0
C
      WRITE(6,250) N18SER, ADTSER
  250 FORMAT( //2X, 'N18SER = ', F10.3, 2X, 'ADTSER = ', F6.1,//)
      WRITE(6,260) (NSING(I), I = 1, 13)
```

```
  260 FORMAT( ' NSING = ', 13F8.1 // )
      WRITE(6,262) (NTAND(I), I = 1, 16 )
  262 FORMAT( ' NTAND = ', 13F8.1 // 9X, 3F8.1 // )
C
      RETURN
      END
C
C
C
C
      SUBROUTINE  FINDA1 ( ADT, AKIP, A1 )
      DIMENSION   AUPL(6), EUPL(3)
      DIMENSION   ADTF(6), EALF(3)
      DATA AUPL   /0.0, 300.0, 750.0, 2000.0, 75000.0, 250000.0/
      DATA ADTF   /1.00, 0.96, 0.92, 0.88, 0.84, 0.80/
      DATA EUPL   /0.0, 6.0, 12.0/
      DATA EALF   /1.00, 0.95, 0.90/
      DO 2100 K = 1, 5
      IF ( ADT .LT. AUPL(K+1) ) GO TO 2200
 2100 CONTINUE
      K           = 6
 2200 Z1          = ADTF(K)
      DO 2300 K = 1, 2
      IF ( AKIP .LT. EUPL(K+1) ) GO TO 2400
 2300 CONTINUE
      K           = 3
 2400 Z2          = EALF(K)
      A1          = 1.00 / ( Z1 * Z2 )
      RETURN
      END
C
C
C
C
      SUBROUTINE FINDRF ( RFAL, FTCC, V )
      DIMENSION   V(8), RUPL(2), FUPL(3), RFFR(2), FTFR(3)
      DATA RUPL   /20.0, 40.0/
      DATA RFFR   /0.97, 0.94/
      DATA FUPL   /10.0, 30.0, 50.0/
      DATA FTFR   /0.973, 0.967, 0.960/
      RF          = 1.0
      IF ( RFAL .LE. RUPL(1) ) GO TO 1200
      RF          = RFFR(2)
      IF ( RFAL .GT. RUPL(2) ) GO TO 1200
      RF          = RFFR(1)
 1200 CONTINUE
      FF          = 1.00
      IF ( FTCC .LE. FUPL(1) ) GO TO 1500
      FF          = FTFR(3)
      IF ( FTCC .GT. FUPL(3) ) GO TO 1500
      FF          = FTFR(2)
      IF ( FTCC .GT. FUPL(2) ) GO TO 1500
      FF          = FTFR(1)
 1500 CONTINUE
      V(1)        = 1.00 / RF
      V(2)        = V(1)
      V(3)        = 1.0
      V(4)        = V(1)
      V(5)        = V(1) / FF
      V(6)        = V(5)
      V(7)        = V(5)
      V(8)        = V(5)
      RETURN
      END
C
C
C
C
C
C
C
      SUBROUTINE UTLTY1 ( RX,V,Z)
      DIMENSION   A(8), B(8), U(8), V(8), RX(8)
      DATA     A   /-0.2540, -0.3396, -0.6703, -0.8106,
     1               -1.4918, -0.8607, -1.0000, -0.7408/
      DATA     B   /- 18.940, -  9.770, - 42.580, - 59.700,
     1               - 6.2044, - 43.750, -191.200, -  8.892/
      U(1)        = 1.00
      DO 1100 I = 1, 8
      IF ( RX(I) .GT. 0.5) GOTO 1000
```

```
      U(I) = 1.0
      GOTO 1100
 1000 U(I) = 1.0 + A(I) *  EXP( B(I) / RX(I))
 1100 CONTINUE
 1200 CONTINUE
      Z          = 1.0
      DO 1500 K = 1, 8
      Z          = Z * U(K) ** V(K)
 1500 CONTINUE
      RETURN
      END
C
C
C
C
C
C
C
      SUBROUTINE  UTLTY2 ( X, Y, Z )
      DIMENSION   A(3,3), B(3)
      DATA    A   /0.8, 1.3, 1.8, 2.0, 2.5, 3.0, 2.5, 3.0, 3.5/
      DATA    B   /-0.26666, -0.55833, -0.85000/
      Z          = 0.0
      IF ( Y .LT. 0.0 ) GO TO 2000
      NC         = 3
      IF ( X .GT. 165000 ) GO TO 1300
      NC         = 2
      IF ( X .GT.  27500 ) GO TO 1200
      NC         = 1
 1200 CONTINUE
 1300 Z          = 1.00
      IF ( Y .GE. A(NC,3) ) GO TO 2000
      IF ( Y .LT. A(NC,2) ) GO TO 1500
      Z          = 1.00 - 0.4 * ( A(NC,3) - Y ) ** 2
      GO TO 2000
 1500 IF ( Y .LT. A(NC,1) ) GO TO 1600
      Z          = B(NC) + 0.58333 * Y
      GO TO 2000
 1600 Z          = 0.20 * ( Y / A(NC,1) ) ** 2
 2000 CONTINUE
      RETURN
      END
C
C
C
C
C
C
C
      SUBROUTINE UTLTY4 ( Y, Z)
C
C       Y = AREA OF ROAD COVERED BY PATCHING
C       THIS SUBROUTINE
C          A) CALCULATES THE COST ASSOCIATED WITH Y
C          B) CALCULATES A UTILITY SCORE FOR THAT COST ( REFER PES)
C
C
C          IF Y = 10%  COST ASSUMED EQUAL TO $1400 (WHERE U DECR )
C          IF Y = 75% COST ASSUMED EQUAL TO $3100 ( U = 0 )
C          LINEAR INTERPOLATION USE FOR Y BETWEEN 10 AND 100
C
      IF   ( Y .GT. 10) GOTO 1000
      Z    = 1.0
      GOTO 2000
 1000 CONTINUE
      COST = 1400.0 + 26.15 * ( Y -10.0 )
      Z    = 1.0 - 0.13*(((COST - 1400.0)/700.0) ** 2)
      IF ( COST .GT. 2100.0 ) Z = 2.69 - 0.00087 * COST
      IF ( Z .LT. 0.0 ) Z = 0.0
 2000 CONTINUE
      RETURN
      END
C
C
C
C
C
C
C
C
```

```
      SUBROUTINE TINDUS ( NSTAT, NDATES, IW, TPER, MTYPE, TRAF,
     * DISTSN, DISTAN, ESING, ETAND, PCTIND )
C
C     ************************************************************
C
C     THIS SUBROUTINE RETURNS THE COMPLETED TRAF ARRAY FOR A MILL
C     TO THE MAIN PROGRAM
C
C     ************************************************************
C
      DIMENSION TRAF(240,4), IW(60,3), TPER(60)
      DIMENSION DISTSN(10,13), DISTAN(10,16), ESING(13), ETAND(16)
      REAL N18TIM, ADTTIM, PERCNT, TPER
      READ(5,10)MTYPE
   10 FORMAT (I1)
      CALL MILL(MTYPE,N18TIM,ADTTIM,NSTAT,DISTSN,DISTAN,
     * ESING, ETAND, PCTIND)
      READ (5,20) NDATES
   20 FORMAT (I3)
      DO 110 I = 1, NDATES
      READ (5,30,END=710) IDATE, CHANGE
   30 FORMAT (I3,1X,F4.2)
      IW(I,1)=IDATE
      TPER(I) =CHANGE
      CALL ADDMIL( IDATE, CHANGE, N18TIM, ADTTIM, TRAF)
  110 CONTINUE
      GO TO 700
  710 WRITE (6,720)
  720 FORMAT( 1H1, ' ERROR IN INPUT DATA', /
     *      10X, ' NUMBER OF INPUT DATES DOES NOT MATCH ACTUAL NO.')
  700 CONTINUE
      RETURN
      END
C
C
C
C
C
      SUBROUTINE MILL(MTYPE, N18TIM, ADTTIM, NSTAT, DISTSN, DISTAN,
     *  ESING, ETAND, PCTIND )
C
C     ************************************************************
C
C     THIS SUBROUTINE RETURNS 18K ESAL AND ADT PER MONTH ASSOCIATED
C     WITH A MILL
C
C     ************************************************************
C
      REAL N18, NSING, NTAND, NSINGL, NTANDM, N18SIN, N18TAN
      REAL N18TIM
      DIMENSION DISTSN(10,13),DISTAN(10,16),ESING(13),ETAND(16),
     *  NSING(13),NTAND(16),NSINGL(10),NTANDM(10),TTYPE(10),
     *  SINGLE(10),TANDEM(10),ATYPE(10),BTYPE(10),CTYPE(10)
C
C
      DATA SINGLE / 2.0,1.0,3.0,2.0,1.0,5.0,2.0,3.0,2.0,1.0 /
      DATA TANDEM / 0.0,1.0,0.0,1.0,2.0,0.0,2.0,0.0,1.0,2.0 /
      DATA ATYPE / 64.0,46.0,2.0,12.0,362.0,5*0.0 /
      DATA BTYPE / 8.0,3*0.0,286.0,5*0.0 /
      DATA CTYPE / 28.0,4.0,0.0,6.0,146.0,0.0,6.0,3*0.0 /
C
      IF (MTYPE .EQ. 1) GO TO 100
      IF (MTYPE .EQ. 2) GO TO 150
      IF (MTYPE .EQ. 3) GO TO 200
  100 CONTINUE
      DO 700 I=1, 10
      TTYPE(I)=ATYPE(I)
  700 CONTINUE
      ADTTIM=2318.0
      GO TO 500
  150 CONTINUE
      DO 710 I=1, 10
  710 TTYPE(I)=BTYPE(I)
      ADTTIM=954.0
      GO TO 500
  200 CONTINUE
      DO 720 I=1, 10
  720 TTYPE(I)=CTYPE(I)
      ADTTIM=822.0
      GO TO 500
```

```
      500 CONTINUE
          NTYP=10
C
C
          DO 10 I = 1, NTYP
          NSINGL(I)=TTYPE(I)*SINGLE(I)
          NTANDM(I)=TTYPE(I)*TANDEM(I)
       10 CONTINUE
C
C
          DO 14 J=1,13
       14 NSING(J)=0.0
C
          DO 15 J=1,16
       15 NTAND(J)=0.0
C
C
          DO 30 K=1,10
          DO 20 J=1,13
       20 NSING(J)=NSING(J)+NSINGL(K)*DISTSN(K,J)/100.0
       30 CONTINUE
C
C
          DO 50 K=1,10
          DO 40 J=1,16
       40 NTAND(J)=NTAND(J)+NTANDM(K)*DISTAN(K,J)/100.0
       50 CONTINUE
C
C
          N18SIN=0.0
C
          DO 60 J=1,13
       60 N18SIN=N18SIN+NSING(J)*ESING(J)
C
C
          N18TAN=0.0
          DO 70 J=1,16
       70 N18TAN=N18TAN + NTAND(J)*ETAND(J)
C
          N18=N18SIN + N18TAN
C
C         TTYPE ARE FOR ONE DAY THEREFORE N18 ARE FOR ONE DAY.
C         N18TIM ARE FOR A MONTH.
C         N18TIM AND ADTTIM MUST BE MULTIPLIED BY PCTIND TO GET NUMBER
C              OF 18 KIP ESAL AND ADT IN THE DESIGN LANE
C
          N18TIM=N18*30
          N18TIM=N18TIM*PCTIND/100
C
C
          WRITE (6,250) MTYPE, N18TIM, ADTTIM
      250 FORMAT( //2X, ' THE MILL IS TYPE ',I1,2X,'N18TIM = ',F10.3,
     *    2X,'ADTTIM = ',F6.1,//)
          RETURN
          END
C
C
C
C
C
C
          SUBROUTINE ADDMIL(IDATE,CHANGE,N18TIM,ADTTIM, TRAF)
C
C         ***********************************************************
C
C         ADDS MILL ADT AND N18 TO THE TRAF ARRAY
C
C         ***********************************************************
C
          DIMENSION TRAF(240,4)
          REAL N18TIM, ADTTIM, PERCNT, TRAF
C
C         THIS ONLY ADDS OR SUBTRACT THE CHANGE IN PRODUCTION (TRAFFIC)
C              PER MONTH
C
          WRITE(6,400) IDATE,TRAF(IDATE,1),TRAF(IDATE,2),
     *   TRAF(IDATE,3),TRAF(IDATE,4)
          DO 10 I=IDATE,240
          TRAF(I,2) = TRAF(I,2) + CHANGE*ADTTIM*30
          TRAF(I,4) = TRAF(I,4) + CHANGE*N18TIM
```

```
   10 CONTINUE
  400 FORMAT(2X,' MONTH',I3,' INITIAL TRAF(I,1)=',F9.0,'TRAF(I,2)=',
     *  F9.0,' TRAF(I,3)=',F9.0, ' TRAF(I,4)=',F9.0)
      WRITE(6,410) IDATE, TRAF(IDATE,1),TRAF(IDATE,2),
     *   TRAF(IDATE,3),TRAF(IDATE,4)
  410 FORMAT( 2X,' MONTH=',I3,' TRAF(1)=',F9.0,'TRAF(2)=',F9.0,
     *  'TRAF(3)',F9.0,'TRAF(4)',F9.0)
      RETURN
      END
C
C
C
C
C
      SUBROUTINE SITE ( NSTAT, DISTSN, DISTAN, ESING, ETAND, NDATES,
     * IW, MTYPE, TRAF, PCTIND)
C
C     **********************************************************
C
C     THIS SUBROUTINE RETURNS THE COMPLETED TRAF ARRAY FOR A CUTTING
C     SITE TO THE MAIN PROGRAM
C
C     **********************************************************
C
      DIMENSION TRAF(240,4), IW(60,3)
      DIMENSION DISTSN(10,13),DISTAN(10,16),ESING(13),ETAND(16)
      REAL N18CLE, ADTCLE, N18SEL, ADTSEL, TRUCLE, TRUSEL
C
      CALL CUT(NSTAT, N18CLE, ADTCLE, N18SEL, ADTSEL,
     * DISTSN, DISTAN, ESING, ETAND, TRUCLE, TRUSEL, PCTIND)
      READ(5,20) NDATES
   20 FORMAT(I3)
      DO 110 I=1, NDATES
      READ(5,30,END=710) IDATE, NACRES, NCUT
   30 FORMAT(I3,1X,I3,1X,I1)
      IW(I,1)=IDATE
      IW(I,2)=NACRES
      IW(I,3)=NCUT
C
C
      CALL ADDCUT ( IDATE, NACRES, NCUT, N18CLE, N18SEL, ADTCLE,
     1     ADTSEL, TRAF, TRUCLE, TRUSEL )
  110 CONTINUE
      GO TO 700
  710 WRITE (6,720)
  720 FORMAT ( 1H1, ' ERROR IN INPUT DATA',/
     *     10X, ' NUMBER OF INPUT DATES DOES NOT MATCH ACTUAL NO.')
  700 CONTINUE
      RETURN
      END
C
C
C
C
C
      SUBROUTINE CUT( NSTAT, N18CLE, ADTCLE, N18SEL, ADTSEL,
     * DISTSN, DISTAN, ESING, ETAND, TRUCLE, TRUSEL, PCTIND )
C
C     ***********************************************************
C
C     THIS SUBROUTINE RETURNS 18K ESAL AND ADT PER ACRE ASSOCIATED
C     WITH A CUTTING SITE
C
C     ADTCLE=NUMBER OF PASSENGER CARS AT A CLEAR CUTTING SITE
C        PER MONTH
C     ADTSEL=NUMBER OF PASSENGER CARS AT A SELECTIVE CUTTING
C        SITE PER MONTH
C     TRUCLE=NUMBER OF TRUCKS AT A CLEAR CUTTING SITE PER ACRE
C     TRUSEL=NUMBER OF TRUCKS AT A SELECTIVE CUTTING SITE PER ACRE
C
C     ***********************************************************
C
      REAL N18, NSING, NTAND, NSINGL, NTANDM, N18SIN, N18TAN
      REAL N18CLE, ADTCLE, N18SEL, ADTSEL, TRUCLE, TRUSEL
      DIMENSION DISTSN(10,13),DISTAN(10,16),ESING(13),ETAND(16),
     *  NSING(13),NTAND(16),NSINGL(10),NTANDM(10),SINGLE(10),
     *  TANDEM(10),TTYPE(10),BTYPE(10)
C
C
C
```

```
C
C
      DATA SINGLE / 2.0,1.0,3.0,2.0,1.0,5.0,2.0,3.0,2.0,1.0 /
      DATA TANDEM / 0.0,1.0,0.0,1.0,2.0,0.0,2.0,0.0,1.0,2.0 /
C
      DATA TTYPE / 4*0.0, 6.0, 5*0.0 /
      ADTCLE = 200.0
      TRUCLE=6.0
      NTYP = 10
      DO 10 I= 1, NTYP
        NSINGL(I) = TTYPE(I) * SINGLE(I)
        NTANDM(I) = TTYPE(I) * TANDEM(I)
   10 CONTINUE
      DO 14 J = 1, 13
   14 NSING(J)=0.0
      DO 15 J = 1, 16
   15 NTAND(J) = 0.0
      DO 30 K = 1, 10
      DO 20 J = 1, 13
   20 NSING(J) = NSING(J)+NSINGL(K)*DISTSN(K,J)/100.0
   30 CONTINUE
C
C
      DO 50 K = 1, 10
      DO 40 J = 1, 16
   40 NTAND(J) = NTAND(J)+NTANDM(K)*DISTAN(K,J)/100.0
   50 CONTINUE
C
C
      N18SIN=0.0
C
      DO 60 J = 1, 13
   60 N18SIN=N18SIN+NSING(J)*ESING(J)
C
C
      N18TAN = 0.0
      DO 70 J = 1, 16
   70 N18TAN=N18TAN + NTAND(J)*ETAND(J)
C
C
      N18=N18SIN+N18TAN
      N18CLE=N18*PCTIND/100
C
C
C
      DATA BTYPE / 4*0.0, 3.0, 5*0.0 /
      ADTSEL=200.0
      TRUSEL=3.0
C
C
      NTYP = 10
      DO 110 I=1, NTYP
        NSINGL(I)=BTYPE(I)*SINGLE(I)
        NTANDM(I)=BTYPE(I)*TANDEM(I)
  110 CONTINUE
C
      DO 114 J = 1, 13
  114   NSING(J)=0.0
      DO 115 J = 1, 16
  115 NTAND(J) = 0.0
      DO 130 K= 1, 10
      DO 120 J=1,13
  120 NSING(J)=NSING(J)+NSINGL(K)*DISTSN(K,J)/100.0
  130 CONTINUE
C
C
      DO 150 K = 1, 10
      DO 140 J=1,16
  140 NTAND(J)=NTAND(J)+NTANDM(K)*DISTAN(K,J)/100.0
  150 CONTINUE
C
C
      N18SIN=0.0
      DO 160 J=1,13
  160 N18SIN=N18SIN+NSING(J)*ESING(J)
C
C
      N18TAN=0.0
      DO 170 J=1,16
  170 N18TAN=N18TAN+NTAND(J)*ETAND(J)
```

```
C
      N18=N18SIN+N18TAN
      N18SEL=N18*PCTIND/100
      RETURN
      END
C
C
C
C
C
C
      SUBROUTINE ADDCUT (IDATE, NACRES, NCUT, N18CLE, N18SEL,
     *   ADTCLE, ADTSEL, TRAF, TRUCLE, TRUSEL )
C
C     ******************************************************************
C
C     THIS SUBROUTINE ADDS CUTTING SITE ADT AND N18 TO THE
C     TRAF ARRAY
C
C     ******************************************************************
C
C
C
      DIMENSION TRAF(240,4)
      REAL N18CLE, N18SEL, ADTCLE, ADTSEL, TRUCLE, TRUSEL
C
C
C
      IF (NCUT.EQ.2.0) THEN DO
        X1=ADTCLE
        X2=N18CLE
        X3=TRUCLE
      GO TO 15
      END IF
C
      IF (NCUT.EQ.1.0) THEN DO
        X1=ADTSEL
        X2=N18SEL
        X3=TRUSEL
      ELSE DO
        WRITE(6,700)
  700 FORMAT( // . ' ERROR IN INPUT DATA', /
     *   10X, ' TYPE OF CUT WAS NOT 1 OR 2')
      END IF
C
C
   15 CONTINUE
      DO 10 I = IDATE, 120
        TRAF(I,2)=TRAF(I,2) + NACRES*X3 + X1
        TRAF(I,4)=TRAF(I,4)+NACRES*X2
   10 CONTINUE
      RETURN
      END
C
C
C
C
C
C
      SUBROUTINE LOAD (NSTAT,DISTSN,DISTAN,ESING,ETAND,PERCNT)
C
C
C     THIS SUBROUTINE CONTAINS THE VALUES FROM THE WEIGHT TABLES
C       PT=2.5
C       DISTS1=STATION 501--LUBBOCK COUNTY
C       DISTS2=STATION 502--GUADALUPE COUNTY
C       DISTS3=STATION 503--KIMBLE COUNTY
C       DISTS4=STATION 504--NOLAN COUNTY
C       DISTS5=STATION 505--NACOGDOCHES COUNTY
C       DISTS6=STATION 506--WICHITA COUNTY
C       DISTS7=STATE OF TEXAS AVERAGE
C
C       DISTSN - CONTAINS THE SINGLE AXLE LOAD DISTRIBUTIONS AS
C                MEASURED AT WEIGHING STATIONS FOR EACH TRUCK TYPE
C       DISTAN - CONTAINS THE TANDEM AXLE LOAD DISTRIBUTION FOR
C                EACH TRUCK TYPE
C       ESING -  CONTAINS EQUIVALENCY FACTORS FOR SINGLE WHEEL LOADS
C       ETAND -  CONTAINS EQUIVALENCY FACTORS FOR TANDEM WHEEL LOADS
C       PERCNT - CONTAINS THE PERCENTAGE OF EACH TRUCK TYPE IN THE
C                TRAFFIC STREAM
```

```
C
C
      DIMENSION DISTSN(10,13),DISTAN(10,16),ESING(13),ETAND(16),
     *  PERCNT(10)
C
      DIMENSION DISTS1(10,13),DISTA1(10,16),ESIN1(13),ETAN1(16),
     * PERCN1(10)
      DIMENSION DISTS2(10,13),DISTA2(10,16),ESIN2(13),ETAN2(16),
     * PERCN2(10)
      DIMENSION DISTS3(10,13),DISTA3(10,16),ESIN3(13),ETAN3(16),
     * PERCN3(10)
      DIMENSION DISTS4(10,13),DISTA4(10,16),ESIN4(13),ETAN4(16),
     * PERCN4(10)
      DIMENSION DISTS5(10,13),DISTA5(10,16),ESIN5(13),ETAN5(16),
     * PERCN5(10)
      DIMENSION DISTS6(10,13),DISTA6(10,16),ESIN6(13),ETAN6(16),
     * PERCN6(10)
      DIMENSION DISTS7(10,13),DISTA7(10,16),ESIN7(13),ETAN7(16),
     * PERCN7(10)
C
C
C
      DATA DISTS1 / 7.6,3.3,8*0.0,55.8,16.7,18.5,7.6,3.4,
     * 20.0,18.8,3*0.0,8.0,13.3,3.7,19.7,10.7,40.0,6.3,3*0.0,
     * 14.5,60.0,63.0,39.4,79.4,20.0,43.8,3*0.8,7.2,6.7,14.8,
     * 16.7,6.1,20.0,12.5,3*0.0,3.3,2*0.0,6.1,0.2,5*0.0,0.7,3*0.0,
     * 0.2,5*0.0,1.4,2*0.0,6.1,2*0.0,6.3,3*0.0,1.1,2*0.0,3.0,6*0.0,
     * 0.4,5*0.0,12.5,3*0.0,10*0.0,3*0.0,1.5,6*0.0,10*0.0 /
C
      DATA DISTA1 / 4*0.0,0.1,5*0.0,0.0,25.9,0.0,12.1,18.4,0.0,25.0,
     * 4*0.0,25.9,0.0,45.5,22.2,0.0,25.0,3*0.0,0.0,11.1,0.0,30.3,
     * 12.1,0.0,25.0,3*0.0,0.0,11.1,0.0,6.1,14.3,0.0,25.0,3*0.0,0.0,
     * 18.5,0.0,3.0,7.1,9*0.0,1.8,9*0.0,5.9,6*0.0,3.7,0.0,3.0,5.5,
     * 9*0.0,5.8,9*0.0,3.5,9*0.0,1.7,6*0.0,3.7,2*0.0,0.7,9*0.0,0.5,
     * 9*0.0,0.4,5*0.0,10*0.0 /
C
      DATA ESIN1 / 0.0002,0.005,0.032,0.087,0.36,0.796,1.06,1.307,
     * 1.826,2.583,3.533,5.389,9.432 /
C
      DATA ETAN1 / 0.01,0.01,0.044,0.148,0.426,0.753,0.885,1.002,
     * 1.23,1.533,1.885,2.289,2.749,3.264,4.17,5.10 /
C
      DATA PERCN1  / 19.5,4.0,1.3,4.7,69.9,0.1,0.5,3*0.0 /
C
C
      DATA DISTS2/5*0.0,0.7,4*0.0,46.9,9.1,32.5,10.8,5.3,32.4,4*0.0,
     * 11.3,14.8,10.0,15.6,18.9,13.1,4*0.0,22.8,58.0,42.5,42.0,75.4,
     * 35.9,25.0,3*0.0,8.6,14.8,12.5,18.8,0.4,9.0,25.0,3*0.0,7.1,
     * 1.1,0.8,7.6,0.0,5.5,12.5,4*0.0,2.3,0.0,0.8,0.0,0.7,4*0.0,1.8,
     * 2*0.0,1.6,0.0,1.4,37.5,3*0.0,1.0,0.0,1.7,2.0,0.0,0.0,0.7,4*0.0,
     * 0.4,2*0.0,0.4,0.0,0.7,4*0.0,3*0.0,0.4,6*0.0,10*0.0,10*0.0/
C
      DATA DISTA2 / 10*0.0,0.0,25.0,0.0,27.2,17.9,6*0.0,36.4,0.0,
     * 42.4,24.5,6*0.0,10.2,0.0,23.2,11.9,0.0,50.0,4*0.0,18.2,
     * 0.0,4.8,18.3,0.0,50.0,6*0.0,0.8,11.6,5*0.0,3*0.0,1.6,1.9,
     * 6*0.0,1.1,2*0.0,5.1,6*0.0,3.4,2*0.0,5.0,6*0.0,3.4,2*0.0,
     * 2.3,9*0.0,1.0,5*0.0,0.0,1.1,2*0.0,0.2,6*0.0,1.1,2*0.0,0.1,
     * 5*0.0,4*0.0,0.1,5*0.0,10*0.0,10*0.0 /
C
      DATA PERCN2 / 14.8,3.9,1.8,5.5,72.6,1.3,0.1,3*0.0 /
C
      DATA ESIN2 / 0.0002,0.005,0.032,0.087,0.36,0.796,1.06,
     * 1.037,1.826,2.583,3.533,5.389,9.432 /
C
      DATA ETAN2 / 0.01,0.01,0.044,0.148,0.426,0.753,0.885,
     * 1.002,1.23,1.533,1.885,2.289,2.749,3.269,4.17,5.1 /
C
C
      DATA DISTS3/3.1,3*0.0,0.1,5*0.0,55.4,16.7,31.3,6.4,3.6,20.0,
     * 8.7,3*0.0,9.9,11.1,12.5,7.4,18.8,10.0,8.7,3*0.0,17.0,50.0,
     * 39.6,55.3,76.8,38.3,52.2,3*0.0,10.2,22.2,8.3,11.7,0.7,15.0,
     * 26.1,3*0.0,4.4,0.0,2.1,13.8,0.0,6.7,4.3,5*0.0,2.1,3.2,8*0.0,
     * 4.2,1.1,0.0,6.7,7*0.0,1.1,0.0,3.3,4*0.0,10*0.0,10*0.0,
     * 10*0.0,10*0.0 /
C
      DATA DISTA3 / 4*0.0,0.1,6*0.0,3.3,0.0,36.7,18.7,0.0,14.3,
     * 4*0.0,27.8,0.0,22.4,19.4,0.0,14.3,4*0.0,33.3,0.0,32.7,
     * 12.4,0.0,71.4,6*0.0,8.2,18.6,9*0.0,10.8,9*0.0,2.6,9*0.0,
     * 6.8,6*0.0,5.6,2*0.0,6.7,9*0.0,2.7,9*0.0,0.8,9*0.0,0.2,
     * 9*0.0,0.2,5*0.0,10*0.0,10*0.0,10*0.0 /
```

```
C
      DATA PERCN3 / 15.3,1.9,1.7,5.0,74.3,1.2,0.6,3*0.0 /
C
      DATA ESIN3 / 0.0002,0.005,0.032,0.087,0.36,0.796,1.06,1.307,
     * 1.826,2.583,3.533,5.389,9.432 /
C
      DATA ETAN3 / 0.01,0.01,0.044,0.148,0.420,0.753,0.885,1.002,
     * 1.23,1.533,1.885,2.289,2.749,3.269,4.17,5.1 /
C
C
      DATA DISTS4/1.3,9*0.,42.7,14.8,14.1,6.3,3.1,3.3,22.2,3*0.,9.6,
     * 5.6,12.8,5.,5.8,2.9,4*0.,23.7,42.6,33.3,45.6,87.3,38.3,38.9,
     * 2*0.,100.,10.4,31.5,25.6,20.6,2.9,38.8,25.,3*0.,4.2,3.7,9.,
     * 11.9,0.8,9.6,4*0.0,2.1,0.0,2*1.3,0.,1.3,4*0.,4.2,1.9,1.3,6.3,
     * 0.1,3.8,4*0.,1.0,0.0,2*1.3,0.0,2.1,2.8,3*0.,0.5,0.0,1.3,3*0.,
     * 5.6,6*0.0,1.9,2*0.0,2.8,3*0.,0.3,5*0.0,2.8,13*0.0 /
C
C
      DATA DISTA4 / 10*0.0,0.0,16.7,0.0,7.5,6.5,0.0,33.3,4*0.0,
     * 14.8,0.0,30.0,12.4,0.0,22.2,2*0.0,100.0,0.0,9.3,0.0,47.5,
     * 16.4,0.0,11.1,4*0.0,13.0,0.0,12.5,23.4,0.0,33.3,4*0.0,5.6,
     * 2*0.0,12.2,9*0.0,3.0,6*0.0,9.3,0.0,1.3,7.3,6*0.0,5.6,0.0,1.3,
     * 9.1,6*0.,3.7,2*0.,4.7,6*0.,7.4,2*0.,2.4,6*0.,7.4,2*0.,1.2,
     * 6*0.,3.7,2*0.,0.5,6*0.,1.9,2*0.,0.3,6*0.,1.9,2*0.,0.4,15*0. /
C
      DATA  PERCN4  /  11.7,3.3,1.6,4.9,75.0,2.9,0.5,2*0.0,0.1  /
C
      DATA ESIN4  /  0.0002,0.005,0.032,0.087,0.36,0.796,1.06,1.307,
     *   1.826,2.583,3.533,5.389,9.432  /
C
      DATA  ETAN4  /  0.01,0.01,0.044,0.148,0.420,0.753,0.885,1.002,
     *   1.23,1.533,1.885,2.289,2.749,3.269,4.17,5.1  /
C
C
C
      DATA DISTS5 / 0.5,3*0.0,0.1,5*0.0,50.5,3.3,16.7,7.4,2.4,15.0,
     * 4*0.0,14.1,18.0,11.1,5.6,4.7,5.0,4*0.0,21.5,67.2,44.4,47.2,
     * 89.2,20.0,4*0.0,5.6,8.2,24.1,19.4,2.3,25.0,4*0.0,4.5,3.3,1.9,
     * 8.3,1.2,30.0,4*0.0,0.8,2*0.0,1.9,0.0,5.0,4*0.0,1.6,2*0.0,5.6,
     * 6*0.0,0.3,2*0.0,3.7,6*0.0,0.5,2*0.0,0.9,8*0.0,1.9,27*0.0 /
C
C
      DATA DISTA5/0.0,24.6,2*0.0,0.1,6*0.0,27.9,0.0,14.8,13.9,6*0.0,
     * 21.3,0.0,37.0,21.0,6*0.0,11.5,0.0,27.8,13.3,6*0.0,1.6,0.0,
     * 14.8,14.3,8*0.0,5.6,9.6,6*0.0,6.6,2*0.0,2.4,9*0.0,7.6,6*0.0,
     * 3.3,2*0.0,6.6,6*0.0,3.3,2*0.0,4.9,9*0.0,3.5,9*0.0,1.7,
     * 9*0.0,1.0,9*0.0,0.1,9*0.0,0.2,15*0.0/
C
      DATA PERCN5 / 26.5,4.4,1.3,3.9,63.5,0.4,4*0.0 /
C
      DATA ESIN5 / 0.002,0.005,0.032,0.087,0.36,0.796,1.06,1.307,
     * 1.826,2.583,3.533,5.389,9.432 /
C
      DATA ETAN5 / 0.01,0.01;0.044,0.148,0.426,0.753,0.885,1.002,
     * 1.23,1.533,1.885,2.289,2.749,3.269,4.17,5.1 /
C
C
      DATA DISTS6 /0.9,3*0.0,0.1,10.0,4*0.0,54.3,9.4,19.5,16.7,2.4,
     * 8.1,16.7,3*0.0,12.1,4.7,3.4,6.3,14.1,58.1,5.6,3*0.0,21.3,63.2,
     * 39.1,38.5,81.9,17.5,30.6,3*0.0,5.2,21.7,20.7,20.8,1.2,3.1,
     * 38.9,3*0.0,3.7,0.9,12.6,9.4,0.0,0.6,5.6,3*0.0,0.9,2*0.0,2.1,
     * 0.1,2.5,2.8,3*0.0,0.3,0.0,1.1,3.1,6*0.0,0.9,0.0,2.3,2.1,6*0.0,
     * 0.3,0.0,1.1,1.0,6*0.0,0.3,9*0.0,4*0.0,0.1,5*0.0,10*0.0 /
C
C
      DATA DISTA6 /11*0.0,0.9,0.0,12.5,8.2,6*0.0,18.9,0.0,50.0,18.8,
     * 0.0,22.2,4*0.0,17.9,0.0,22.9,14.7,0.0,11.1,4*0.0,11.3,0.0,8.3,
     * 20.4,0.0,66.7,4*0.0,5.7,2*0.0,10.7,6*0.0,0.9,2*0.0,2.7,6*0.0,
     * 1.9,2*0.0,7.3,6*0.0,8.5,2*0.0,8.3,6*0.0,12.3,0.0,6.3,5.3,
     * 6*0.0,6.6,2*0.0,2.4,6*0.0,4.7,2*0.0,0.9,6*0.0,2.8,2*0.0,0.2,
     * 6*0.0,6.6,2*0.0,0.2,6*0.0,0.9,2*0.0,0.1,15*0.0/
C
C
      DATA PERCN6 / 13.5,8.2,2.2,3.7,69.2,2.5,0.7,3*0.0 /
C
      DATA ESIN6 / 0.0002,0.005,0.032,0.087,0.36,0.796,1.06,1.307,
     * 1.826,2.583,3.533,5.389,9.432 /
C
      DATA ETAN6 / 0.01,0.01,0.044,0.148,0.426,0.753,0.885,1.002,
     * 1.23,1.533,1.885,2.289,2.749,3.269,4.17,5.10 /
```

```
      C
            DATA DISTS7/1.7,0.3,2*0.,0.1,.2,4*0.,50.,10.1,23.2,9.3,3.6,13.8,
           * 16.,3*0.,11.,10.6,9.2,10.2,12.6,7.6,4.2,3*0.,20.8,58.5,41.3,44.4,
           * 81.5,42.1,38.7,2*0.,100.,8.,2*17.9,18.5,1.9,23.7,27.2,3*0.,4.9,
           * 1.7,5.1,9.4,0.4,7.3,3.4,3*0.,.7,.6,.5,1.4,0.,1.,.8,3*0.,1.7,.3,
           * 1.,3.6,0.,3.,3.4,3*0.,.8,0.,1.2,2.1,0.,1.3,.8,3*0.,.4,0.,.5,.4,
           * 0.,.2,3.4,5*0.,.2,.5,2*0.,.8,6*0.,.1,2*0.,.8,13*0.0 /
      C
      C
            DATA DISTA7/11*0.0,16.9,0.0,19.5,13.6,0.0,16.1,4*0.0,25.1,0.0,
           * 37.8,19.7,0.0,19.4,2*0.0,100.0,0.0,15.5,0.0,30.6,13.6,0.0,29.0,
           * 4*0.0,12.7,0.0,8.7,18.8,0.0,35.5,4*0.0,4.2,0.0,1.3,10.8,6*0.0,
           * 0.3,0.0,0.5,2.4,6*0.0,3.4,0.0,0.3,6.6,6*0.0,4.8,0.0,0.5,6.9,
           * 6*0.0,5.6,0.0,0.8,4.0,6*0.0,3.7,2*0.0,2.1,6*0.0,2.8,2*0.0,0.8,
           * 6*0.,2.,2*0.,0.4,6*0.,2.3,2*0.,0.2,6*0.,0.6,2*0.0,0.2,15*0. /
      C
            DATA PERCN7 / 14.6,4.4,1.7,4.8,72.5,1.6,0.4,3*0.0 /
      C
            DATA ESIN7 / 0.0002,0.005,0.032,0.087,0.36,0.796,1.06,1.307,
           * 1.826,2.583,3.533,5.389,9.432 /
      C
            DATA ETAN7 / 0.01,0.01,0.044,0.148,0.426,0.753,0.885,1.002,
           * 1.23,1.533,1.885,2.289,2.749,3.269,4.17,5.1 /
      C
      C
      C
      C
      C
            IF (NSTAT.EQ.1) GO TO 10
            IF (NSTAT.EQ.2) GO TO 20
            IF (NSTAT.EQ.3) GO TO 30
            IF (NSTAT.EQ.4) GO TO 40
            IF (NSTAT.EQ.5) GO TO 50
            IF (NSTAT.EQ.6) GO TO 60
            IF (NSTAT.EQ.7) GO TO 70
            WRITE(6,900)
        900 FORMAT(1H1,' ERROR IN INPUT OF STATION VALUE')
      C
      C
         10 CONTINUE
             DO 100 J=1,10
                  PERCNT(J)=PERCN1(J)
                  DO 110 K=1,13
        110          DISTSN(J,K)=DISTS1(J,K)
                  DO 120 I=1,16
        120       DISTAN(J,I)=DISTA1(J,I)
        100 CONTINUE
            DO 130 K=1,13
        130    ESING(K)=ESIN1(K)
            DO 140 I=1,16
        140    ETAND(I)=ETAN1(I)
            GO TO 800
      C
      C
      C
         20 CONTINUE
             DO 200 J=1,10
                  PERCNT(J)=PERCN2(J)
                  DO 210 K=1,13
        210          DISTSN(J,K)=DISTS2(J,K)
                  DO 220 I=1,16
        220       DISTAN(J,I)=DISTA2(J,I)
        200 CONTINUE
            DO 230 K=1,13
        230    ESING(K)=ESIN2(K)
            DO 240 I=1,16
        240    ETAND(I)=ETAN2(I)
            GO TO 800
      C
      C
      C
         30 CONTINUE
             DO 300 J=1,10
                  PERCNT(J)=PERCN3(J)
                  DO 310 K=1,13
        310          DISTSN(J,K)=DISTS3(J,K)
                  DO 320 I=1,16
        320       DISTAN(J,I)=DISTA3(J,I)
        300 CONTINUE
            DO 330 K=1,13
```

```
  330    ESING(K)=ESIN3(K)
      DO 340 I=1,16
  340    ETAND(I)=ETAN3(I)
      GO TO 800
C
C
C
   40 CONTINUE
       DO 400 J=1,10
           PERCNT(J)=PERCN4(J)
           DO 410 K=1,13
  410         DISTSN(J,K)=DISTS4(J,K)
           DO 420 I=1,16
  420      DISTAN(J,I)=DISTA4(J,I)
  400 CONTINUE
      DO 430 K=1,13
  430    ESING(K)=ESIN4(K)
      DO 440 I=1,16
  440    ETAND(I)=ETAN4(I)
      GO TO 800
C
C
C
   50 CONTINUE
       DO 500 J=1,10
           PERCNT(J)=PERCN5(J)
           DO 510 K=1,13
  510         DISTSN(J,K)=DISTS5(J,K)
           DO 520 I=1,16
  520      DISTAN(J,I)=DISTA5(J,I)
  500 CONTINUE
      DO 530 K=1,13
  530    ESING(K)=ESIN5(K)
      DO 540 I=1,16
  540    ETAND(I)=ETAN5(I)
      GO TO 800
C
C
C
   60 CONTINUE
       DO 600 J=1,10
           PERCNT(J)=PERCN6(J)
           DO 610 K=1,13
  610         DISTSN(J,K)=DISTS6(J,K)
           DO 620 I=1,16
  620      DISTAN(J,I)=DISTA6(J,I)
  600 CONTINUE
      DO 630 K=1,13
  630    ESING(K)=ESIN6(K)
      DO 640 I=1,16
  640    ETAND(I)=ETAN6(I)
      GO TO 800
C
C
C
   70 CONTINUE
       DO 700 J=1,10
           PERCNT(J)=PERCN7(J)
           DO 710 K=1,13
  710         DISTSN(J,K)=DISTS7(J,K)
           DO 720 I=1,16
  720      DISTAN(J,I)=DISTA7(J,I)
  700 CONTINUE
      DO 730 K=1,13
  730    ESING(K)=ESIN7(K)
      DO 740 I=1,16
  740    ETAND(I)=ETAN7(I)
      GO TO 800
C
C
C
  800 CONTINUE
      RETURN
      END
C
C
C
C
C
C
```

```
C
//$DATA
   1    12.5     3.57    4.82    0.900   76.7   65.4
   2   -39.3     1.14    8.48    0.637   77.8   63.3
   3    11.7     3.60    3.81    0.430   78.1   66.7
   4   -10.3     3.10    0.610   0.167   78.0   70.6
   5   -16.2     2.35    5.83    0.854   76.3   63.9
   6   -17.5     1.69    12.7    0.802   72.2   57.5
   7   -22.3     2.36    2.30    0.325   81.9   70.0
   8    4.46     3.40    2.71    0.540   79.5   68.0
   9   -21.9     1.40    12.8    0.993   72.3   56.9
  10   -11.4     2.59    5.52    0.504   79.6   65.7
  11   -10.7     2.91    2.92    0.341   79.1   67.6
  12   -19.0     2.21    8.57    0.659   76.3   62.5
  13   -15.9     2.64    1.64    0.276   80.9   69.7
  14   -12.5     2.77    3.97    0.361   79.2   66.8
  15   -15.7     2.50    2.49    0.385   79.5   68.6
  16   -6.67     2.85    4.62    0.652   78.4   65.5
  17   -30.4     1.64    6.74    0.608   77.0   63.3
  18   -10.2     2.76    4.99    0.762   77.1   65.2
  19    49.1     4.01    8.03     1.04   75.1   63.0
  20    38.5     4.64    1.70    0.207   78.5   68.5
  21    4.59     3.55    2.07    0.400   77.9   67.7
  22   -31.6     1.08    3.36    0.486   79.8   66.4
  23   -17.9     1.81    10.2    0.809   72.8   58.6
  24   -28.0     2.17    1.53    0.202   84.0   71.8
  25   -19.1     2.36    5.79    0.580   77.4   65.0
  26    2.10     3.30    2.96    0.430   78.2   67.4
  27   -13.9     2.64    4.14    0.458   78.2   65.9
  28   -6.16     2.92    3.03    0.573   79.4   67.6
  29    1.15     3.61    0.862   0.237   79.4   70.6
  30   -19.7     2.24    5.74    0.920   77.7   64.5
  31   -27.7     2.28    0.387   0.040   83.8   73.3
  32    47.4     3.85    5.36    0.960   75.2   63.5
  33   -18.7     1.71    10.4     1.34   72.6   58.2
  34    49.2     3.97    6.95     1.16   75.1   63.0
  35   -22.1     1.52    12.1    0.938   72.5   57.0
  36    39.1     4.29    2.21    0.461   78.8   68.3
  37    35.3     3.89    4.34    0.646   76.0   65.0
  38   -26.1     1.73    7.92    0.767   74.4   61.5
  39   -14.1     2.65    7.08    0.888   75.8   63.2
  40   -20.4     1.50    11.4    0.853   73.1   57.9
  41   -28.6     1.80    6.08    0.633   77.9   64.4
  42   -16.6     2.27    5.47    0.642   75.4   63.2
  43    16.1     3.19    5.39    0.849   74.8   64.0
  44   -22.8     1.75    9.62    0.737   75.0   61.0
  45    5.62     3.55    3.05    0.650   79.9   68.4
  46   -9.79     2.84    2.73    0.620   80.1   68.0
  47   -15.4     2.44    5.70    0.770   76.6   64.5
  48   -25.0     2.07    5.17    0.635   80.0   65.8
  49    18.6     2.84    7.33     1.25   74.6   62.5
  50   -14.1     2.78    5.23    0.587   78.6   66.0
  51   -25.1     1.89    7.40    0.853   76.3   62.8
  52   -39.8     1.16    5.82    0.604   77.9   64.1
  53   -32.8     1.55    5.85    0.445   78.5   64.6
  54   -20.7     1.77    10.9     1.10   73.5   59.2
  55   -44.1     0.852   7.08    0.597   77.6   62.8
  56   -20.4     1.47    12.9    0.915   70.0   55.1
  57   -1.36     3.05    4.08    0.530   76.1   66.1
  58   -32.5     1.41    9.20    0.575   76.1   61.3
  59   -21.4     1.64    11.7    0.926   73.3   58.5
  60    56.1     3.82    6.86     1.05   74.2   62.9
  61    8.85     3.02    4.69    0.810   76.7   65.0
  62   -10.1     2.98    2.57    0.342   81.3   69.3
  63   -26.8     1.70    7.65    0.615   75.5   61.9
  64   -26.8     1.78    1.44    0.075   84.6   71.9
  65   -20.0     1.74    11.7    0.994   73.6   59.0
  66   -28.4     2.24    0.985   0.105   84.4   72.4
  67   -28.7     2.14    1.68    0.130   83.3   71.1
  68   -15.3     2.39    6.72    0.657   76.1   63.4
  69   -38.7     1.17    5.96    0.547   77.3   63.6
  70   -26.4     1.90    3.92    0.253   78.2   65.4
  71   -2.03     3.17    4.97    0.680   77.6   65.6
  72   -46.6     0.678   9.52    0.508   78.2   61.8
  73   -6.52     2.69    6.01    0.874   74.8   63.2
  74   -7.31     3.12    4.44    0.429   78.9   67.0
  75    57.9     3.66    5.13    0.743   75.2   63.7
  76    1.94     3.27    2.30    0.502   79.5   68.8
  77   -26.9     1.87    7.01    0.820   77.6   63.8
  78   -21.8     1.68    9.76     1.06   73.4   58.9
```

2157.	79	-22.6	1.95	9.88	0.721	74.9	61.5
2158.	80	13.1	3.86	1.70	0.367	78.8	68.5
2159.	81	46.2	3.82	5.60	1.14	74.6	62.9
2160.	82	9.49	3.39	3.74	0.524	77.4	66.2
2161.	83	-22.9	2.11	1.66	0.260	83.4	70.7
2162.	84	-33.1	1.33	9.79	1.03	76.6	61.2
2163.	85	18.4	3.38	0.417	0.125	74.4	69.7
2164.	86	-23.5	1.75	8.82	0.922	74.7	60.8
2165.	87	-18.5	2.41	3.44	0.530	78.0	65.9
2166.	88	-35.6	1.31	7.32	0.628	76.5	62.7
2167.	89	-13.7	3.06	1.42	0.325	82.1	71.0
2168.	90	-14.5	2.78	2.89	0.466	80.9	68.9
2169.	91	-16.3	1.72	10.7	1.20	71.2	57.4
2170.	92	46.3	3.21	5.02	0.608	74.5	63.4
2171.	93	36.2	4.04	4.77	0.880	76.2	64.8
2172.	94	5.74	3.49	3.52	0.450	79.5	67.8
2173.	95	-16.3	2.62	2.74	0.387	79.8	68.6
2174.	96	-20.4	1.60	11.9	0.862	72.3	58.0
2175.	97	-24.5	1.75	9.48	0.565	75.1	61.1
2176.	98	-12.4	2.60	4.88	0.667	76.6	64.6
2177.	99	-20.7	1.64	11.7	0.929	73.0	57.8
2178.	100	-22.3	1.95	9.88	0.721	74.9	61.5
2179.	101	34.8	4.35	3.34	0.389	78.8	66.6
2180.	102	11.2	4.01	1.28	0.250	78.8	69.0
2181.	103	39.7	3.83	5.95	0.907	76.0	64.4
2182.	104	-22.0	1.39	13.6	1.13	70.1	55.4
2183.	105	-22.8	2.13	6.44	0.808	76.3	63.5
2184.	106	-8.34	2.87	4.09	0.669	79.0	67.1
2185.	107	-22.8	1.67	11.7	0.825	73.6	59.5
2186.	108	7.04	3.43	3.27	0.581	77.9	66.4
2187.	109	-37.0	1.82	0.462	0.050	84.1	73.7
2188.	110	-7.70	2.94	4.16	0.590	76.9	65.4
2189.	111	-20.1	1.62	11.2	1.20	74.4	59.2
2190.	112	-7.10	2.68	5.64	1.12	75.3	63.3
2191.	113	67.2	3.81	6.69	1.02	74.8	63.0
2192.	114	14.0	3.54	5.67	0.842	77.6	65.6
2193.	115	-33.7	1.50	6.43	0.666	77.3	64.1
2194.	116	-41.7	0.910	7.14	0.477	77.2	61.7
2195.	117	41.6	3.55	5.74	1.22	74.4	63.1
2196.	118	-23.4	1.63	10.3	1.01	73.0	59.1
2197.	119	-30.6	1.65	6.73	0.794	77.5	64.4
2198.	120	-18.2	2.45	4.66	0.530	77.9	65.5
2199.	121	7.78	3.67	2.50	0.617	79.8	68.5
2200.	122	26.9	4.31	3.00	0.512	78.7	66.4
2201.	123	-11.7	1.60	6.35	0.953	69.2	57.3
2202.	124	31.5	4.49	1.62	0.400	78.0	68.4
2203.	125	-33.2	1.94	1.01	0.193	84.1	72.2
2204.	126	-21.8	2.52	0.810	0.133	83.1	71.8
2205.	127	-10.5	2.83	4.93	0.632	78.2	65.9
2206.	128	-25.9	2.06	5.17	0.495	78.1	65.4
2207.	129	-15.7	2.84	2.14	0.458	82.6	70.4
2208.	130	8.35	3.35	5.54	1.00	76.3	64.6
2209.	131	-6.99	2.77	4.04	0.540	77.7	65.5
2210.	132	-28.8	1.66	8.34	0.580	76.6	62.2
2211.	133	-8.38	2.57	6.55	0.800	77.3	63.9
2212.	134	-27.6	1.88	6.08	0.598	79.8	65.5
2213.	135	-23.0	1.89	8.00	0.577	75.9	61.9
2214.	136	-31.9	1.86	2.55	0.200	81.0	68.4
2215.	137	-25.5	2.33	0.809	0.158	83.3	72.3
2216.	138	-24.5	2.01	7.21	0.730	76.8	63.5
2217.	139	48.0	3.94	6.36	1.12	74.1	63.2
2218.	140	-16.9	1.55	12.6	0.921	72.6	57.8
2219.	141	-14.7	2.69	4.01	0.510	78.7	66.5
2220.	142	-31.7	1.90	1.54	0.300	83.1	71.2
2221.	143	-2.41	3.31	2.44	0.276	81.5	69.6
2222.	144	-8.83	2.88	3.17	0.491	78.7	67.6
2223.	145	7.31	3.32	3.91	0.770	77.9	65.9
2224.	146	30.6	4.18	2.80	0.437	79.3	68.1
2225.	147	4.30	3.27	3.50	0.582	76.3	65.6
2226.	148	-17.2	1.66	11.7	0.777	70.6	56.8
2227.	149	-19.1	2.61	1.58	0.224	81.0	69.9
2228.	150	-21.9	2.29	5.07	0.570	78.8	65.9
2229.	151	-46.1	0.845	7.71	0.483	80.7	64.8
2230.	152	-25.8	1.55	10.2	1.04	73.3	59.7
2231.	153	-24.9	1.60	9.69	0.967	74.4	60.1
2232.	154	2.00	3.49	3.52	0.450	79.5	67.8
2233.	155	38.7	3.77	6.06	0.886	75.8	64.3
2234.	156	-38.5	1.14	7.05	0.593	76.7	62.7
2235.	157	-21.3	2.19	5.18	0.523	78.6	65.2
2236.	158	4.39	3.69	0.880	0.125	78.8	70.6

2237.	159	-30.4	1.89	2.21	0.153	82.8	70.3
2238.	160	-19.1	2.22	5.76	0.841	77.4	64.0
2239.	161	-15.5	2.71	2.71	0.413	77.6	67.0
2240.	162	-29.2	1.95	2.04	0.262	82.9	70.9
2241.	163	-19.2	2.41	2.72	0.312	82.4	69.2
2242.	164	-22.4	2.08	6.58	0.625	79.5	64.9
2243.	165	-38.6	1.18	6.78	0.780	76.5	63.3
2244.	166	-10.5	2.90	2.71	0.437	79.8	68.1
2245.	167	-18.9	2.35	4.64	0.530	77.7	65.6
2246.	168	-25.4	1.94	6.20	0.730	79.4	65.3
2247.	169	0.214	2.67	4.71	0.850	76.7	64.8
2248.	170	13.1	3.91	3.33	0.392	79.0	67.5
2249.	171	-20.8	1.48	12.8	0.734	72.2	57.4
2250.	172	32.2	3.85	4.33	0.704	77.3	65.8
2251.	173	-25.2	1.74	8.10	0.720	75.0	61.6
2252.	174	39.6	4.18	5.32	0.880	77.2	65.0
2253.	175	3.70	3.20	4.76	0.812	76.6	65.3
2254.	176	33.1	4.74	3.27	0.500	79.5	67.2
2255.	177	-21.6	2.08	6.11	0.880	76.7	63.7
2256.	178	-19.1	2.56	0.520	0.200	80.7	71.6
2257.	179	-15.6	1.76	11.9	1.38	71.3	57.1
2258.	180	-18.2	1.51	12.5	1.21	69.9	55.4
2259.	181	40.1	4.60	3.15	0.385	78.2	67.0
2260.	182	-13.5	2.62	5.23	0.720	76.8	64.9
2261.	183	25.8	3.88	4.24	0.564	77.5	65.7
2262.	184	-7.32	2.70	5.71	1.10	75.4	63.3
2263.	185	-25.9	1.37	13.6	1.09	71.6	56.7
2264.	186	-42.4	0.997	7.11	0.646	79.2	64.1
2265.	187	23.5	4.08	3.97	0.650	78.1	66.2
2266.	188	-17.6	1.65	11.6	1.16	70.5	57.1
2267.	189	-3.45	1.02	7.79	0.417	79.9	62.8
2268.	190	34.5	3.73	6.55	0.904	75.1	63.2
2269.	191	-21.0	1.62	11.7	0.897	73.4	58.5
2270.	192	-31.1	1.51	7.27	0.780	76.8	63.2
2271.	193	-21.8	2.15	5.81	0.404	78.0	64.7
2272.	194	47.5	3.86	6.87	1.02	74.4	62.8
2273.	195	-46.6	0.821	8.31	0.383	81.6	64.9
2274.	196	-9.92	3.28	1.36	0.151	81.9	71.0
2275.	197	-15.8	1.76	11.9	1.38	71.4	57.1
2276.	198	1.27	3.26	3.82	0.610	78.3	66.6
2277.	199	-1.72	2.85	4.88	0.914	76.5	64.6
2278.	200	-26.7	1.88	6.74	0.610	78.4	64.6
2279.	201	30.0	3.91	4.65	0.692	75.9	64.7
2280.	202	36.6	4.29	4.43	0.665	77.2	64.8
2281.	203	36.0	4.11	4.93	0.753	77.3	65.2
2282.	204	25.5	4.03	5.05	0.610	77.9	66.3
2283.	205	-18.4	2.84	0.961	0.243	82.0	71.3
2284.	206	-22.3	2.16	5.51	0.731	77.6	64.5
2285.	207	-27.3	1.77	7.10	0.505	77.8	64.2
2286.	208	-25.8	1.75	8.55	0.744	76.3	62.3
2287.	209	-15.3	2.33	7.01	0.932	77.7	63.7
2288.	210	39.0	4.21	5.52	0.914	77.2	64.8
2289.	211	-20.1	1.47	12.9	0.915	70.0	55.1
2290.	212	-19.5	1.52	11.6	0.961	71.1	56.5
2291.	213	-9.30	2.74	5.69	0.820	77.6	64.8
2292.	214	-41.2	1.62	0.680	0.100	85.6	73.5
2293.	215	-17.1	2.33	6.27	0.990	77.1	64.3
2294.	216	-30.2	1.67	6.73	0.720	77.8	63.8
2295.	217	-26.6	1.86	7.62	0.966	77.4	63.3
2296.	218	-27.6	1.85	5.64	0.528	79.3	65.4
2297.	219	-22.7	1.52	11.1	0.992	72.0	57.2
2298.	220	-3.79	2.83	4.77	1.05	76.0	64.8
2299.	221	-22.4	2.14	5.14	0.800	76.0	64.3
2300.	222	-40.4	1.11	5.98	0.379	78.3	64.0
2301.	223	-25.3	1.55	11.0	0.901	74.3	59.4
2302.	224	-19.5	2.21	6.79	0.840	75.9	63.3
2303.	225	47.0	3.92	7.28	1.10	75.5	62.9
2304.	226	-31.3	1.65	6.56	0.730	77.1	64.2
2305.	227	-14.3	2.72	2.27	0.617	78.5	68.1
2306.	228	17.9	3.87	4.11	0.644	78.1	66.3
2307.	229	30.8	4.33	3.63	0.311	78.8	66.5
2308.	230	42.1	3.84	5.26	0.930	75.1	63.5
2309.	231	-38.3	1.29	5.56	0.364	78.9	65.4
2310.	232	-28.7	2.03	3.77	0.341	81.6	68.6
2311.	233	-38.6	1.39	3.51	0.299	80.4	67.7
2312.	234	17.5	3.65	4.54	0.842	76.2	64.4
2313.	235	-8.68	3.01	1.52	0.375	80.6	69.9
2314.	236	10.8	3.71	3.17	0.560	77.9	67.0
2315.	237	16.3	3.70	3.06	0.325	78.9	67.5
2316.	238	-44.4	0.934	6.38	0.497	79.7	64.8

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        239    3.27      3.40      2.71     0.540      79.5      68.0
        240   -33.6      1.90      1.22     0.218      84.0      72.0
        241    3.30      3.57      2.27     0.488      79.7      68.6
        242   -21.8      1.75      10.7     0.787      74.1      59.8
        243   -15.3      2.28      6.35     0.890      75.3      63.4
        244   -21.5      2.19      5.92     0.727      77.4      64.1
        245   -28.1      2.25     0.737     0.117      84.1      72.9
        246   -12.3      2.96      3.23     0.599      79.6      67.6
        247   -19.0      2.49      1.99     0.382      80.7      69.1
        248   -44.2     0.921      7.38     0.570      78.8      64.2
        249   -12.0      2.51      6.43     0.820      77.2      64.0
        250    9.81      2.59      9.73      1.16      73.4      60.0
        251   -25.5      1.41      10.5     0.715      74.1      58.7
        252   -14.9      2.48      8.77     0.800      76.9      63.7
        253   -40.1      1.63     0.886     0.182      84.6      72.9
        254   -30.2      1.87      1.61     0.117      82.7      71.0
       35
         1.5  50.  30.  80.  30.  80.  30.  50.  50.  70.  30.  70.  30.
       PSI      RUTTING RAVELINGFLUSHINGALGR+PATLONG CRKTRNS CRK
       236     8.800      1.20      25.2      36.00
           1     6    12    18    24    30    36    42    48    54    60    66    72    78    84    90
         CUTTING SITE AT SAM HOUSTON NATIONAL FOREST
          1000. 11.0  5.0 50.0
       5
       3
        30.0
       007
       018 400 2
       019 400 2
       020 400 2
       021 400 2
       022 400 2
       023 400 2
       024 400 2
       /*END
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XX        XX  XX       XX    XX                      XX            XXXXXXXXXX    XXXXXXXXX    XXXXXXXXXX             XXXXXXXXX
XX        XX   XX     XX     XX                      XX            XXXXXXXXXX   XXXXXXXXXXX   XXXXXXXXXX            XXXXXXXXXXX
XX        XX    XX  XX       XX                      XX                XX       XX        XX      XX                XX        XX
XX        XX     XXXX        XX                      XX                XX       XX                XX                XX        XX
XX   X    XX      XX         XX                      XX                XX       XXXXXXXXXX        XX                XX        XX
XX  XXX   XX      XX         XX                      XX                XX        XXXXXXXXXX       XX                XX        XX
XX XX XX XX       XX         XX                      XX                XX                XX       XX                XX        XX
XXXX   XXXX       XX         XX                      XX                XX       XX        XX      XX                XX        XX
XXX     XXX       XX         XXXXXXXXXXX             XXXXXXXXXXX   XXXXXXXXXX   XXXXXXXXXXX       XX                XXXXXXXXXXX
XX       XX       XX         XXXXXXXXXXX             XXXXXXXXXXX   XXXXXXXXXX    XXXXXXXXX        XX                 XXXXXXXXX
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********************* I T E M I Z E D   J O B   C O S T **********************
*                                                                            *
* BOX        JOB NAME           COMMENTS              DATE       JOB NUMBER *
* 505D       W341TT01       WYL/LIST OFFLINE      17.35.48    85.009   6893   *
*                                                                            *
* I T E M                   QUANTITY             COST       PREVIOUS         *
*                                                           BALANCE     78.116 *
* CPU                       5.09  SECONDS         0.407                      *
* CARD IMAGES READ          2399  IMAGES          0.720                      *
* XEROX PRINT SIMPLEX         17  PAGES           0.493                      *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                                            *
*                                                    TOTAL CHARGES     1.620 *
*                                                                            *
* PRIORITY 5                  DPSR W341            CURRENT BALANCE    76.496 *
*                                                                            *
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XXXXXXXXXXX    XXXXXXX    XXXXXXXXXXX  XXXXXXXXX                                 XXXXXXXXX    XXXXXXXXX    XXXXXXXXX    XXXXXXXXX
XXXXXXXXXXX   XXXXXXXXX   XXXXXXXXXXX  XXXXXXXXXX                               XXXXXXXXXXX  XXXXXXXXXXX  XXXXXXXXXXX  XXXXXXXXXXX
XX            XXX     XXX XX           XX        XX                             XX        XX XX        XX XX        XX XX        XX
XX            XX       XX XX           XX        XX                             XX           XX        XX XX        XX           XXX
XXXXXXXXXX    XX       XX XXXXXXXXXX   XX        XX                             XXXXXXXXXX    XXXXXXXXX   XXXXXXXXXXX        XXXX
XXXXXXXXXXX   XX       XX XXXXXXXXXXX  XX        XX                             XXXXXXXXXXX   XXXXXXXXX    XXXXXXXXXX        XXXX
         XX   XX       XX          XX  XX        XX                             XX        XX XX        XX           XX           XXX
XX       XX   XXX     XXX XX       XX  XX        XX                             XX        XX XX        XX           XX XX        XX
XXXXXXXXXXX   XXXXXXXXX   XXXXXXXXXXX  XXXXXXXXXX                               XXXXXXXXXXX  XXXXXXXXXXX  XXXXXXXXXXX  XXXXXXXXXXX
 XXXXXXXXX     XXXXXXX     XXXXXXXXX   XXXXXXXXX                                 XXXXXXXXX    XXXXXXXXX    XXXXXXXXX    XXXXXXXXX
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7.3 Texas Bridge Formula

COMMERCIAL VEHICLE REGISTRATION DATA

$$W=500\left(\frac{LN}{N-1}+12N+36\right)$$ L=length & N= # of axles

Distance In Feet	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles
4	34,000					
5	34,000					
6	34,000					
7	34,000					
8	34,000	42,000				
9	39,000	42,500				
10	40,000	43,500				
11		44,000				
12		45,000	50,000			
13		45,500	50,500			
14		46,500	51,500			
15		47,000	52,000			
16		48,000	52,500	58,000		
17		48,500	53,500	58,500		
18		49,900	54,000	59,000		
19		51,400	54,500	60,000		
20		52,800	55,500	60,500	66,000	
21		54,300	56,000	61,000	66,500	
22		55,800	56,500	61,500	67,000	
23		57,200	57,500	62,500	68,000	
24		58,700	58,700	63,000	68,500	74,000
25		59,650	59,650	63,500	69,000	75,500
26		60,600	60,600	64,000	69,500	75,000
27		61,550	61,550	65,000	70,000	75,500
28		62,500	62,500	65,500	71,000	76,500
29		63,450	63,450	66,000	71,500	77,000
30		64,400	64,400	66,500	72,000	77,500
31		65,350	65,350	67,500	72,500	78,000
32		66,300	66,300	68,000	73,000	78,500
33			67,250	68,500	74,000	79,000
34			68,200	69,000	74,500	80,000
35			69,150	70,000	75,000	
36			70,100	70,500	75,500	
37			71,050	71,050	76,000	
38			72,000	72,000	77,000	
39			72,000	72,500	77,500	
40			72,000	73,000	78,000	
41			72,000	73,500	78,500	
42			72,000	74,000	79,000	
43			72,000	75,000	80,000	
44			72,000	75,500		
45			72,000	76,000		
46			72,500	76,500		
47			73,500	77,500		
48			74,000	78,000		
49			74,500	78,500		
50			75,500	79,000		
51			76,000	80,000		

*These figures have been carried forward from the table contained in the old law based upon the provisions of Subsection (4), Article 6701d-11, Section 5, V.C.S., as amended by Senate Bill Number 89 of the 64th Legislature.