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MAJOR STREET AND HIGHWAY STUDY PHOENIX-MARICOPA COUNTY, ARIZONA

PROGRESS REPORT NO. 3

MARCH, 1959

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March 5, 1959

Mr. John Beatty, Chairman
Coordinating Committee
Phoenix-Maricopa County Area Study
827 East Jefferson Street
Phoenix, Arizona

Progress Report No. 3
Period Ending February 28, 1959

Dear Mr. Beatty:

Detailed studies of basic traffic flow characteristics in the Phoenix-Maricopa County Area were continued during February. Based on these characteristics, roadway capacity standards have been established for various types of street and highway facilities. By relating traffic demands to available capacities, the adequacy of existing streets and highways can be determined. Studies of base-year traffic volumes, traffic desires, and traffic generation characteristics were also continued as well as various inventories of existing roadway conditions. The principal findings of these studies, to the extent that the studies have been completed, are summarized in the following progress report. Preliminary illustrations related to this work have also been prepared and are presented separately in working form for your comments and suggestions.

Traffic Capacity - One of the more important phases of any investigation of major street and highway needs is the determination of the traffic capacity standards against which traffic demands are to be related to establish deficiencies. The major street and highway network for the Phoenix-Maricopa County Area will be designed to accommodate the frequent peak periods of traffic demand expected in 1980. The volume of 1980 traffic demand will be related to the combined capacity of the various existing streets in each traffic corridor. Thus, capacity is a quantitative measure of the ability of a roadway to accommodate traffic.

Capacity standards also reflect the quality of traffic flow - a factor of considerable importance. The following traffic capacity criteria, in general accord with Highway Research Board recommendations, have been applied in this study:

1. POSSIBLE (MAXIMUM) CAPACITY - represents the greatest sustained hourly loading that a facility can accommodate under prevailing roadway and traffic conditions. When traffic volumes exceed the possible capacity, extensive delays and traffic failures result. The traffic in excess of the capacity necessarily redistributes to alternate facilities, if available.

2. PRACTICAL (DESIRABLE) CAPACITY - represents the maximum loading at which a reasonable or desirable level of traffic performance will be attained. When traffic volumes are less than this desirable level, free flow conditions will prevail. Undesirable levels of congestion develop when the practical capacity is exceeded. The major street and highway plan for the Phoenix-Maricopa County Area will in general be designed to operate within practical capacity levels. In most instances, practical capacity is 80 to 85 percent of possible capacity.

Many factors affect the capacity of a street or highway. Capacities increase in general accord with available roadway width in terms of effective moving lanes; they decrease rapidly with the degree of marginal and intersectional interferences or friction. The principal factors which affect roadway capacity adversely include traffic signal controls (particularly multi-phase operations such as are necessary at several intersections along Grand Avenue), curb parking, left turns, heavy truck traffic, narrow lane widths, and pedestrian traffic or special pedestrian phases in traffic signal control.

Basic roadway capacities are determined on the basis of peak hour directional traffic loadings. Average daily capacities are established from relationships between peak hour and average daily traffic volumes. Special studies of local factors affecting the determination of design hour volumes and capacities have been made as will be discussed herein.

Classification of Facilities

The major street and highway plan for the Phoenix-Maricopa County Area will include various types of facilities which fall within three broad classifications as follows:

1. THE FREEWAY-EXPRESSWAY SYSTEM - High capacity, controlled-access facilities designed for high speed, continuous flow with safety for trips of considerable length. As the Phoenix-Maricopa County Area expands, trip distances between major work and residential centers will become greater and traffic volumes will increase greatly. Streets with frequent intersections at grade and marginal friction to traffic caused by necessary land service functions will not provide for the desired quality - or in some instances the quantity - of traffic flow in 1980. An integrated system of controlled-access routes for the area will be located within general corridor limits and tested for need and adequacy. This system will include components for major radial, cross-town, and circumferential traffic movements; will inter-connect principal rural routes entering the area for through traffic services; and will be located, in so far as practical, to provide express service between large residential areas, major employment centers and the central business area. This network of high-capacity, high-speed facilities will be located with regard to the future land-use plan now in preparation by the joint planning staff of the City of Phoenix and Maricopa County. The proposed routes will be

selected to guide orderly development of the region, to logically separate land use areas, and to avoid unnecessary disruption to sound land use planning.

2. THE MAJOR ARTERIAL SYSTEM - Non-limited access streets designed for moderate speeds for traffic movements between areas and across the city, and connecting with the freeway-expressway system. Arterials are generally located at one mile intervals, although heavy traffic demands in the central areas often dictate closer spacing. Arterials may be either divided or undivided, depending upon physical and traffic conditions.

3. THE COLLECTOR STREET SYSTEM - Non-limited access streets providing for traffic movement between arterials and local streets. This system of streets, designed for moderate speeds, performs a secondary function of providing for access to abutting properties. Local streets, which are not a part of this study, are intended to provide for direct land service functions primarily.

Traffic Flow Characteristics

Patterns of traffic variation throughout the typical day, week and year are depicted in Figure 1.

In Figure 1A, the seasonal patterns for two locations are shown; one (Central Avenue) is an arterial serving primarily local traffic; the other (Tempe Bridge) is a through route. The variation in traffic on the through route is much more pronounced than on the local street, varying from a high during the February-March tourist season of 108.5 percent of the annual average volume to a low during August of 87.3 percent. On Central Avenue, the only months during which volumes vary more than three percent from the average are the peak month of December (107.0 percent), and the summer months of July (when a low of 94.3 percent occurs), and August. These extremes can be attributed to the Christmas holiday season in the first instance, and to the vacations of local residents in the second.

Figure 1B illustrates how traffic volumes vary throughout the week. Shown are the daily patterns of variation for a local artery and a through route. The local artery is typical of streets that serve commuter traffic to the downtown area. The volumes during the week are fairly constant with a peak on Friday and a very sharp drop on Sunday. On the other hand, roads serving through movements and traffic to recreation areas do not have this pronounced drop in volume on the weekend.

The characteristics of peak hour traffic were studied at 70 locations throughout Phoenix; the results are summarized in Table 1. The percentage of daily traffic which occurs during the peak hour varies between 6.8 and 13.4 percent, with an average for 70 locations of 9.15 percent. The low values occur on arterial streets which carry high volumes throughout most of the day, while the high percentages occur on streets in outlying areas which have relatively light volumes except during

TABLE 1

PEAK HOUR TRAFFIC CHARACTERISTICS

Phoenix-Maricopa County Area

Location	Daily Volume	Peak Hour Volume	Peak Hour Percent of Total	Peak Hour
SOUTH SCREENLINE				
51st Ave. @ Salt River	843	73	8.7	10-11 a.m.
35th Ave. @ Salt River	2,101	236	11.2	4-5 p.m.
19th Ave. @ Salt River	8,079	698	8.6	5-6 p.m.
Central Ave. @ Salt River	15,755	1,321	8.4	5-6 p.m.
7th Street @ Salt River	3,888	414	10.7	4-5 p.m.
16th Street @ Salt River	10,345	767	7.4	5-6 p.m.
24th Street @ Salt River	3,876	383	10.0	4-5 p.m.
40th Street @ Salt River	3,984	412	10.3	4-5 p.m.
48th Street @ Salt River	1,330	169	12.7	4-5 p.m.
Tempe Bridge	20,011	1,681	8.4	4-5 p.m.
NORTH SCREENLINE				
51st Ave. @ Grand Canal	1,565	184	11.8	5-6 p.m.
43d Ave. @ Grand Canal	3,279	387	11.8	7-8 a.m.
35th Ave. @ Grand Canal	5,816	616	10.6	4-5 p.m.
Grand Ave. @ Grand Canal	15,884	1,260	7.9	5-6 p.m.
27th Ave. @ Grand Canal	4,400	533	12.1	5-6 p.m.
Black Canyon @ Grand Canal	15,036	1,717	11.4	4-5 p.m.
23d Ave. @ Grand Canal	11,171	1,111	10.0	5-6 p.m.
19th Ave. @ Grand Canal	10,858	1,036	9.6	5-6 p.m.
7th Ave. @ Grand Canal	19,278	1,820	9.5	5-6 p.m.
Central Ave. @ Grand Canal	25,088	2,094	8.4	5-6 p.m.
7th Street @ Grand Canal	16,807	1,506	9.0	5-6 p.m.
12th Street @ Grand Canal	5,924	657	11.1	4-5 p.m.
16th Street @ Campbell Ave.	15,223	1,344	8.8	5-6 p.m.
20th Street @ Campbell Ave.	657	88	13.4	8-9 a.m.
24th Street @ Campbell Ave.	6,982	631	9.0	5-6 p.m.
32d Street @ Camelback Rd.	5,623	542	9.6	5-6 p.m.
36th Street @ Camelback Rd.	888	99	11.1	4-5 p.m.
40th Street @ Camelback Rd.	5,171	496	9.6	4-5 p.m.
48th Street @ Arizona Canal	1,874	214	11.4	4-5 p.m.
56th Street @ Arizona Canal	3,632	443	12.2	4-5 p.m.
Scottsdale Rd. @ Osborn Rd.	9,860	783	7.9	12-1 p.m.
Miller Rd. @ Osborn Rd.	952	183	19.2	4-5 p.m.
Hayden Rd. @ Osborn Rd.	1,312	158	11.6	4-5 p.m.

TABLE 1 (Continued)

Location	Daily Volume	Peak Hour Volume	Peak Hour Percent of Total	Peak Hour	Percent in Major Direction
35th Ave. @ Roosevelt	10,186	1,084	10.7	4-5 p.m.	59
15th Ave. @ Encanto Blvd.	8,956	816	9.1	5-6 p.m.	76
7th Street @ McDowell	13,263	1,217	9.2	4-5 p.m.	55
16th Street @ Campbell	15,845	1,387	8.8	5-6 p.m.	70
24th Street @ McDowell	10,175	1,034	10.2	5-6 p.m.	66
24th Street @ Thomas	10,990	1,034	9.4	4-5 p.m.	55
24th Street @ Van Buren	10,185	996	9.8	4-5 p.m.	68
32d Street @ Van Buren	10,175	1,080	10.6	4-5 p.m.	65
McDowell @ 16th Street	21,407	1,751	8.2	4-5 p.m.	58
McDowell @ 7th Street	26,036	1,769	6.8	4-5 p.m.	59
Van Buren @ 24th Street	18,097	1,340	7.4	5-6 p.m.	60
19th Ave. @ Thomas	8,770	858	9.8	7-8 a.m.	65
16th Street @ Thomas	20,513	1,714	8.4	5-6 p.m.	60
27th Ave. @ Highland	8,674	895	10.3	5-6 p.m.	-
17th Ave. @ Adams	10,829	937	8.7	4-5 p.m.	-
1st Street @ Adams	10,695	808	7.6	4-5 p.m.	-
1st Street @ Roosevelt	8,303	688	8.3	5-6 p.m.	-
1st Street @ McDowell	7,281	565	7.8	5-6 p.m.	-
12th Street @ McDowell	5,651	615	10.9	5-6 p.m.	-
12th Street @ Osborn	4,037	524	13.0	5-6 p.m.	-
12th Street @ Indian School	6,382	729	11.4	5-6 p.m.	-
20th Street @ Railroad Tracks	6,145	661	10.8	4-5 p.m.	-
20th Street @ Van Buren	6,367	699	11.0	4-5 p.m.	-
20th Street @ McDowell	6,221	620	10.0	4-5 p.m.	-
20th Street @ Thomas	3,201	367	11.5	4-5 p.m.	-
40th Street @ Van Buren	4,000	416	10.4	4-5 p.m.	-
40th Street @ Thomas	6,900	715	10.4	4-5 p.m.	-
Indian School @ 24th Street	18,557	1,610	8.7	4-5 p.m.	-
Indian School @ Central	16,166	1,407	8.7	4-5 p.m.	-
Jefferson @ 17th Ave.	11,394	1,139	10.0	4-5 p.m.	One-way
Jefferson @ Central	16,569	1,493	9.0	4-5 p.m.	One-way
Jefferson @ 16th Street	14,638	1,739	11.9	5-6 p.m.	One-way
Jefferson @ 9th Street	16,118	1,841	11.4	5-6 p.m.	One-way
Jefferson @ 24th Street	5,058	421	8.3	5-6 p.m.	One-way
McDowell @ 24th Street	20,504	1,710	8.3	5-6 p.m.	-
McDowell @ Central	20,191	1,502	7.4	5-6 p.m.	-
McDowell @ 32d Street	16,470	1,442	8.8	5-6 p.m.	-
McDowell @ 40th Street	13,309	1,151	8.6	5-6 p.m.	-
Totals	705,750	64,530	9.15		64*

* Average, 58 locations

the morning and evening rush periods. Hourly patterns of traffic variation for typical high-volume arterial streets and through highways in the urbanized portion of the study area are illustrated in Figures 1C and 1D.

A check on the hour during which the greatest volume occurs shows at almost every location for which data are available, that the peak hour occurs between 4-6 p.m. Because the major street and highway network must be adequate for the peak demands which occur each day, a special origin and destination tabulation, indicating travel desires of peak period (4 to 6 p.m. traffic) has been prepared to supplement previously prepared tabulations of average daily traffic.

A study of the directional distribution of traffic during the peak hour showed that between 55 and 76 percent of traffic moved in the major direction of flow. The average for 58 locations was 64 percent. The lower values are found close to the center of the city where a sizeable amount of "crosstown" traffic occurs, while the high values occur in the outlying areas. This can be seen by comparing traffic at two screenline locations (Salt River and Grand Canal) with other locations which are scattered between the two screenlines.

The peak directional volume as a percent of average 24 hour, 2-way traffic averages about 5.8 to 5.9 percent in the Phoenix-Maricopa County Area. Peak-hour directional volumes along one-way streets in and near the downtown area comprise 10 to 11 percent of the 24-hour traffic.

Traffic composition as determined at the north and south traffic screenlines in the 1957 study is summarized in Table 2. The percentage of the total volume which is commercial traffic varies widely between locations, with a range of 9 to 35 percent. This includes panel and pick-up trucks which do not affect traffic capacity to a greater extent than passenger vehicles. (Studies indicate that 40-50 percent of the trips made in pickup trucks are for purposes other than business.) The exclusion of pick-up trucks (which were found to amount to 60 percent of all single unit trucks) from the commerical vehicle totals, gives the percentage of medium and heavy commercial traffic, which varies from 4 to 20 percent of total traffic. The higher values are found in the outlying areas having a heavy volume of agricultural truck traffic. Values representative of the Phoenix urban area are those at the north screenline between 19th Avenue and 17th Street, which show from 4 to 7.5 percent medium and heavy commercial traffic. These values are slightly higher than found in many large cities.

Traffic Capacity Standards

Capacity standards have been developed, taking into account the traffic flow characteristics in the study area discussed above. Modern freeways can average about 1,500 vehicles per lane per hour with reasonable facility of flow. Individual lanes of multi-lane facilities can attain higher peak hour totals - as high as 1,800 under favorable conditions. An urban arterial can accommodate between 500 and 600 vehicles per lane per hour, or only one-third the volume of a freeway lane. Figure 2 illustrates comparative unit (per lane) traffic capacities for freeways and surface streets.

TABLE 2

TRAFFIC COMPOSITION

Phoenix-Maricopa County Area

Location	16-Hour Volume [1]	Total Commercial Vehicles	Percent of Total	Medium and Heavy Comm. Vehicles [2]	Percent of Total
51st Ave. @ Salt River	892	315	35.3	178	20.0
35th Ave. @ Salt River	1,754	478	27.3	247	14.9
19th Ave. @ Salt River	6,346	1,802	28.3	888	14.0
Central Ave. @ Salt River	14,237	2,771	19.4	1,278	9.0
7th Street @ Salt River	3,509	930	26.5	431	12.3
16th Street @ Salt River	7,519	1,709	22.8	752	10.0
24th Street @ Salt River	3,575	821	23.0	360	10.1
40th Street @ Salt River	3,289	1,099	33.5	547	16.7
48th Street @ Salt River	1,213	369	30.4	171	14.1
Tempe Bridge	18,215	2,788	15.4	1,370	7.5
Sub Total, South Screenline	60,549	13,082	21.6	6,222	10.3
51st Ave. @ Grand Canal	1,271	318	25.1	169	13.3
43d Ave. @ Grand Canal	2,853	575	20.2	279	9.8
35th Ave. @ Grand Canal	4,977	1,108	22.3	549	11.0
Grand Ave. @ Grand Canal	13,350	3,091	23.2	1,666	12.4
27th Ave. @ Grand Canal	4,723	908	19.2	410	8.7
Black Canyon @ Grand Canal	12,152	1,885	15.6	899	7.4
23d Ave. @ Grand Canal	10,491	1,516	14.4	651	6.2
19th Ave. @ Grand Canal	9,483	1,599	16.9	712	7.5
7th Ave. @ Grand Canal	20,530	2,514	12.2	1,077	5.3
Central Ave. @ Grand Canal	23,946	2,226	9.3	977	4.1
7th Street @ Grand Canal	16,016	2,209	13.8	972	6.1
12th Street @ Grand Canal	5,624	960	17.1	428	7.6
16th Street @ Campbell Ave.	13,712	1,881	13.7	822	6.0
20th Street @ Campbell Ave.	515	114	22.1	49	9.5
24th Street @ Campbell Ave.	6,467	825	12.8	356	5.5
32d Street @ Camelback Rd.	4,724	781	16.5	361	7.6
36th Street @ Camelback Rd.	861	177	20.6	74	8.6
40th Street @ Camelback Rd.	4,786	1,096	22.9	521	10.9
48th Street @ Arizona Canal	1,758	388	22.1	159	9.0
56th Street @ Arizona Canal	5,050	825	16.3	362	7.2
Scottsdale Rd. @ Osborn Rd.	8,196	1,157	14.1	503	6.1
Miller Rd. @ Osborn Rd.	912	137	15.0	47	5.2
Hayden Rd. @ Osborn Rd.	1,271	306	24.1	141	11.1
Sub Total, North Screenline	173,668	26,596	15.2	12,184	7.0

[1] Hours between 6 a.m. and 10 p.m.
[2] Combination Trucks, Buses plus 40 percent of single unit trucks (to exclude panel and pick-up trucks)

Table 3 includes the roadway capacity standards recommended for major street and highway facilities of various types in the Phoenix-Maricopa County Area. The capacity ranges shown are based on the assumptions indicated and on the relationships between peak directional and average daily traffic volumes. For arterial streets, 50 percent effective green signal time was used (including headway losses). It is interesting to note that two four-lane one-way arterial streets are approximately equivalent, capacitywise, to a four-lane freeway. They would not provide the same type of service or quality of operation, however. A six-lane freeway, such as the Black Canyon Highway when completed, will serve as much as 75,000 vehicles per day under satisfactory flow conditions. In comparison, a six-lane arterial with curb parking will adequately serve about 25,000 vehicles per day.

A detailed study of critical intersection capacities was undertaken by the Traffic Engineering Division of the City of Phoenix as part of the 1957 Pilot Study Program of the National Committee on Urban Transportation. Basic data regarding peak hour volumes and physical conditions at each intersection collected for this study have been provided us for our analysis of major street deficiencies.

Since the pilot study on capacity, a new set of capacity curves have been made available by the U. S. Bureau of Public Roads, based upon more recent data which incorporate a wider range of conditions than the original curves, the effect of which is the liberalization of intersection capacities. Using these new curves, we are in the process of re-evaluating the capacities of critical intersections within the study area.

Average Daily Volumes

Figure 3 illustrates the pattern of average daily traffic flow on the principal highways in the metropolitan area outside of the City of Phoenix. Volumes less than 500 vehicles per day have not been shown. The heaviest volumes occur on the state and U. S. numbered routes. U. S. 60-70-89 (Grand Avenue) northwest of Phoenix handles the greatest volume of traffic, an average of 17,400 vehicles per day just west of 27th Avenue. The volume remains high to Glendale and then tapers off gradually with volumes of 7,100 at Peoria and 3,700 at Beardsley. U. S. 80 (Buckeye Road) handles a daily volume of 13,200 vehicles between 43d Avenue and Buckeye. U. S. 60-70-80-89 carries 13,000 vehicles between Tempe and Mesa and 5,000-7,000 vehicles east of Mesa. Other heavy volume routes are State Route 87 south of Mesa and State Route 69 (Black Canyon Highway) north of Phoenix. Local roads handling heavy volumes are Baseline Road, McDowell Road, and several other roads for short distances close to Phoenix.

The average daily volumes of traffic on the arterial streets in the City of Phoenix are shown in Figure 4. Greatest volumes are found on Central Avenue (29,000 north of Thomas Road), which serves heavy local traffic between the downtown business area and the northern residential districts. Other high volumes are found on Camelback, Indian School, Thomas, McDowell and Buckeye Roads; Van Buren, Washington, 7th and 16th Streets; and 7th, 19th, and Grand Avenues.

TABLE 3

RECOMMENDED ROADWAY CAPACITY STANDARDS

Phoenix-Maricopa County Study

Type Facility	Peak Hour Pract. Cap'y[1] Prevailing Direction	Average Daily Practical Capacity
4 lane Freeway	2,400 - 3,000	40,000 - 50,000
6 lane Freeway	4,500 - 4,700	60,000 - 75,000
8 lane Freeway	6,000 - 6,300	80,000 - 100,000
4 lane Expressway[2]	1,200 - 1,400	18,000 - 22,000
2 lane Urban Street (w/parking)	500 - 600	6,500 - 8,500
4 lane Arterial (w/parking)	700 - 1,000	13,000 - 18,000
6 lane Arterial (w/parking)	1,200 - 1,500	20,000 - 25,000
6 lane Arterial (traf. controls)[3]	1,600 - 1,800	26,000 - 30,000
2 lane Arterial (one-way)	700 - 1,000	8,000 - 10,000
4 lane Arterial (one-way)	1,800 - 2,200	16,000 - 22,000
2 lane Rural Road[4]	500 - 800	5,000 - 8,000
4 lane Rural Road[4]	1,000 - 1,200	12,000 - 16,000

1 Average Conditions, light truck traffic
2 Signalized Intersections
3 Median, turn controls, progressive signalization
4 Stop sign control

Table 4 summarizes the average daily volumes found on various high-volume arterials in the Phoenix-Maricopa County Area. These roadways have already been developed to four or six-lane standards to accommodate existing demands. Increased volumes that can be expected in the next two decades will require capacity increases through widening, traffic control techniques, or the construction of new high-capacity facilities of the freeway type.

Traffic at Selected Screen Lines

The base-year average daily traffic demands at four representative screen lines have been tabulated to establish the general magnitudes of major corridor demands. These screen line locations are as follows:

(1) A north-south screen line along and just east of Black Canyon Highway

(2) An east-west screen line at Salt River Crossings

(3) An east-west screen line at the Grand Canal

(4) A north-south screen line between Phoenix and Tempe

East-West Traffic at Black Canyon Highway

The average daily volumes of east-west traffic on streets crossing Black Canyon Highway are shown in Table 5. Streets have been grouped by areas and the subtotals for these areas are also shown. An average daily volume of 137,000 vehicles crossed Black Canyon Highway in 1957, of which 86 percent crossed at or south of Camelback Road. A study of peak hour turning movements at the Camelback and Indian School Road intersections of Black Canyon Highway showed that 70 percent of the east-west traffic passed straight through the intersections (across the Black Canyon Highway frontage roads). Additional counts at other intersections are being made at this time. All future grade separated crossings of Black Canyon Highway are planned as four-lane divided roadways with a 16 foot median.

North-South Traffic at Salt River Bridges

The average daily volume of traffic on the bridges crossing the Salt River are shown in Table 6. A total of about 78,000 vehicles cross the river daily, distributed as indicated. Heavy volumes occur at the Central Avenue bridge, which handles 15,800 vehicles per day, and at Tempe bridge, which has a daily volume of 21,900. Capacity studies of all bridges over the Salt River are now being made.

Traffic at Grand Canal Screenline

Traffic at the Grand Canal screenline is summarized in Table 7. The daily volume across this screenline is about 192,500 vehicles. Approximately 58,000 vehicles cross the screenline in the Central Avenue corridor between 7th Avenue and 7th Street. Another heavy movement of about 39,000 vehicles occurs in the Grand Avenue Black-Canyon Highway corridor.

TABLE 4

PRINCIPAL HEAVY VOLUME ROADWAY SECTIONS

Phoenix-Maricopa County Area

Street	Limits	Range in Average Daily Traffic
Camelback Road	Black Canyon Hwy. -40th St.	15,200-20,700
Indian School Road	Black Canyon Hwy. -40th St.	12,000-20,500
Thomas Road	Black Canyon Hwy. -40th St.	13,700-22,400
McDowell Road	Black Canyon Hwy. -40th St.	12,400-25,200
Van Buren Street	35th Ave. -52d St.	10,900-26,800
Buckeye Road	35th Ave. -24th St.	10,500-15,800
Washington Street	Central Ave. -40th St.	16,200-20,500
19th Avenue	Buckeye Rd. -McDowell Rd.	11,000-15,400
7th Avenue	Buckeye Rd. -McDowell Rd.	9,200-17,500
Central Avenue (south)	Southern Ave. -Washington St.	12,800-19,300
Central Avenue (north)	Washington St. -Camelback Rd.	14,700-29,000
7th Street	Buckeye Rd. -Camelback Rd.	12,000-17,400
16th Street	Buckeye Rd. -Camelback Rd.	10,600-22,900
Grand Avenue	Van Buren St. -Bethany Home Rd.	16,500-22,200

TABLE 5

EAST-WEST TRAFFIC AT BLACK CANYON HIGHWAY

Phoenix-Maricopa County Area

Street		Daily Volume
Durange Street		3,000
Buckeye Road		14,600
Jefferson Street		3,700
Adams Street		5,300
Van Buren Street		16,300
McDowell Road		12,400
	Sub-total	52,000
Grand Avenue		22,200
Thomas Road		13,700
Indian School Road		14,100
Camelback Road		16,300
	Sub-total	66,300
Bethany Home Road		4,900
Glendale Avenue		9,500
Northern Avenue		3,600
	Sub-total	18,000
Olive Avenue		800
Bell Road		200
	Sub-total	1,000
	Total	137,300

TABLE 6

BASE YEAR TRAFFIC ACROSS SALT RIVER BRIDGES

Phoenix-Maricopa County Area

Street		Daily Volume
51st Avenue		850
35th Avenue		2,100
19th Avenue		8,100
	Sub-total	11,050
Central Avenue		15,800
7th Street		3,900
16th Street		10,300
24th Street		3,900
	Sub-total	33,900
40th Street		4,000
48th Street		1,300
	Sub-total	5,300
Tempe Bridge		21,900
Rural Road		4,400
	Sub-total	26,300
	Total	78,000

TABLE 7

NORTH-SOUTH TRAFFIC AT THE GRAND CANAL SCREENLINE

Phoenix-Maricopa County Area

Street		Daily Volume
59th Avenue		1,100
51st Avenue		1,400
43rd Avenue		3,300
35th Avenue		6,600
	Sub-total	12,400
Grand Avenue		17,500
27th Avenue		4,300
Black Canyon Highway		17,100
	Sub-total	38,900
19th Avenue		11,000
15th Avenue		5,500
	Sub-total	16,500
7th Avenue		14,700
Central Avenue		28,000
7th Street		14,900
	Sub-total	57,600
12th Street		6,200
16th Street		15,500
24th Street		8,100
28th Street		2,300
	Sub-total	32,100
32d Street		6,000
36th Street		3,400
40th Street		6,400
44th Street		2,300
48th Street		1,200
56th Street		4,300
	Sub-total	23,600
Scottsdale Road		9,100
Miller Road		1,000
Hayden Road		1,300
	Sub-total	11,400
	Total	192,500

Traffic Between Phoenix and Tempe

Base year average daily traffic volumes on the several streets and highways between Phoenix and Tempe are shown in Table 8. The total screen line volume equals about 40,000 vehicles per day, of which almost half (18,200 vehicles per day) is served by Van Buren and Washington Streets.

TABLE 8

BASE YEAR TRAFFIC BETWEEN PHOENIX AND TEMPE

Phoenix-Maricopa County Area

Street	Average Daily Volume
McDowell Road	8,100
Van Buren Street	7,300
Washington Street	10,900
Sub-total	18,200
Transmission Road	2,400
Broadway Road	3,000
Southern Avenue	1,600
Base Line Road	6,800
Sub-total	13,800
Total	40,100

Base-Year Traffic Generation

Base-year origin and destination data show that a daily volume of 805,011 vehicle trips were generated in the Phoenix-Maricopa County Area. As indicated below, almost 90 percent of these trips were internal - trips with both origin and destination in the study area. Less than one percent of the total volume of traffic generation consisted of through trips - trips with both origin and destination ouside the study area, which were intercepted at the external cordon around the study area. It is clear that new high capacity routes must be located to effectively serve locally generated traffic movements.

BASE-YEAR TRAFFIC GENERATION

Phoenix-Maricopa County Area (225 Sq. Mi. Study Area)

Trips	No. of Vehicles	Percent
Internal	720,124	89.4
External	77,799	9.7
Through	7,088	0.9
Total	805,011	100.0

The distribution of trip termini by district for all vehicle trips made during an average day is shown in Figure 5. The area of the circles are proportional to the total trip termini and the segments represent internal and external trips. The heaviest concentration of termini occurs in the central business district and the adjacent districts north of Van Buren Street.

The distribution of termini of the peak hour downtown traffic is also being prepared. The 1957 survey study data is being processed by business machine methods to obtain the origin and destination information in the desired form.

Inter-district patterns of trip desires in the Phoenix-Maricopa County Area were also analyzed graphically. Desire line charts are particularly useful in locating major corridors of demand where the existing street facilities do not provide for direct travel between principal points of origin and destination.

Internal Traffic Desires

Internal traffic desires of base-year total vehicle traffic between survey districts are illustrated in Figure 6. Separate bands, the width of which are proportioned to the total volume inter-district traffic movement, are shown for all desires in excess of 100 vehicles per day. Traffic desires generated by the central business district are shown in red over the desires generated by all other zones shown in black. The heaviest internal traffic desires are those between the central business district and adjacent districts. Heavy desires also radiate between the central area and the northeast, north and northwest.

External and Through Traffic Desires

The traffic desires of trips of which one or both ends were outside the original study area are shown in Figure 7. External survey stations have been grouped for the purpose of this presentation. The traffic scale used to portray these desire lines is identical with the scale used to illustrate the pattern of internal traffic desires. The heaviest volumes occurred at the external stations on US numbered routes - Tempe Bridge, Grand Avenue and Buckeye Road. Substantial movements occurred between each of these stations and the downtown area. The only heavy through movement occurs between Tempe Bridge and Grand Avenue, which is the route of US 60-70-89, and which will be served by the Phoenix Interstate Freeway.

Inventory Studies

Various inventory studies of physical conditions and roadway operations were continued during February as described below:

PHYSICAL STREET INVENTORIES - A physical street inventory has been prepared by mechanical tabulating methods from data previously collected as discussed in the previous progress report. From this data, a schematic illustration (Figure 8) has been prepared to portray the location of existing right-of-way deficiencies. An inventory of existing traffic control devices

was also prepared by the City of Phoenix Traffic Engineering Division as part of the Pilot Study Program. Both of these sources have been analyzed thoroughly as a background for developing capacity values for specific facilties.

RAILROAD GRADE CROSSINGS INVENTORY - An inventory of all railroad grade crossings in the study area has been compiled. Information included for each crossing show the number of tracks, type of warning devices, volumes of train and motor vehicle traffic, and number of accidents. Warrants for grade separation or warning devices established by the Bureau of Public Roads under the provisions of Section 210 of the Highway Revenue Act of 1956 will be applied to the inventory data. These warrants recommend the presence of flashing lights, gates with flashing lights, or grade separations based on the following criteria:

(1) The product of trains per day and the design-year average daily traffic

(2) Speed of trains

(3) Type of highway

(4) Number of accidents

INVENTORY OF TRAFFIC ACCIDENTS - Motor vehicle accident records have been obtained from the City of Phoenix, Maricopa County and Arizona Highway Department. Figure 9 is an accident spot map of the study area. The size of circles is proportional to the annual number of accidents at a particular location. The large number of accidents at the various intersections of Grand Avenue illustrate the effect of diagonal streets on traffic safety. Excellent cooperation from the various agencies which collect traffic accident data is acknowledged.

Base-Year Land Use Densities

As previously indicated, base-year traffic patterns will be related to several indices of traffic generation, including the following:

(1) Resident population

(2) Employment

(3) Dwelling units

(4) Retail sales activity

(5) Motor vehicle ownership

Estimates of the distribution of the above indices of traffic generation are summarized in preliminary form in Table 9. In addition, the distribution of hotels, motels, trailer parks, apartments, major shopping areas, and major industries have been determined from available data and approximations of the average income level, within five broad classifications, have been completed for each traffic analysis zone.

It is pertinent to note that the population distribution of the 1957 study area indicated a population of 397,395 within the study limits, of which approximately 192,000 were within the City of Phoenix. A total of 79,670 people were living in incorporated areas outside of the study area and 42,935 in unincorporated areas for a total population within Maricopa County of 520,000.

Of the total registration of motor vehicles (243,922) in the county in 1956, 179,829 were passenger cars. Of the total passenger cars, 138,556 were located within the study area, leaving approximately 41,271 passenger cars distributed throughout the rest of the county. Passenger cars per dwelling unit in the study area averaged 1.05 vehicles per dwelling unit, and the average number of persons per car for the study area was 2.86.

There are presently 28 shopping centers of various sizes located within the urban area of Phoenix. There are 3 under construction and 16 in the planning stage. Of the 47 existing, under construction, and planned, 42 are located north of McDowell Road. These large traffic generators must be given important consideration in the future planning of a major street and highway plan.

There are 143,300 employed persons on the county, including military personnel, but excluding agricultural workers. Of the total, approximately 15 percent are employed in the central business district. The majority of the major manufacturing firms are located south of the Grand Avenue-Van Buren Street corridor. The firms with the largest employment are established in areas outside of the downtown industrial area due to the availability of land for large structures. There are 5 firms with over 1,000 employees, 2 firms with 500-1,000, 36 firms with 100-500, and 46 firms with 50-100 employees.

Travel Time Studies

Detailed travel time studies have been made on all principal arterials in the study area. In correlating trip generation with population, employment, and other measures of trip attraction, auto travel time is found to be an important factor. Travel times will also be used in trip assignments to the proposed major street and highway plan. Figure 10 illustrates 2-minute travel time contours developed from data collected during off-peak periods.

Traffic Generation Characteristics

The business machine cards containing the basic origin and destination data collected in the Phoenix-Maricopa County Traffic Study have been received in our

TABLE 9

BASE YEAR LAND USE DENSITIES

PHOENIX-MARICOPA COUNTY AREA

Study Area	1957 Population	Dwelling Units	Number of Jobs	Passenger Cars
A	7,550	1,963	357	2,416
B	9,271	2,944	753	3,473
C	11,310	3,971	921	4,380
D	2,190	815	232	1,041
E	1,540	725	172	906
F	6,040	1,842	363	1,963
G	23,828	6,840	1,389	8,169
H	10,630	3,262	982	4,439
I	7,338	1,933	671	2,113
J	11,400	3,322	837	3,881
K	15,266	5,284	4,044	6,453
L	2,189	739	158	1,012
M	4,364	1,510	1,808	1,963
N	12,382	3,805	4,129	3,850
O	17,135	5,714	2,859	7,305
P	10,299	3,865	6,439	4,408
Q	20,491	6,764	2,746	8,320
R	13,876	5,813	2,774	5,904
S	19,340	7,496	6,292	7,369
T	22,830	7,731	2,440	8,622
U	25,322	7,444	2,235	9,785
V	5,783	1,857	1,461	2,340
W	3,443	1,042	1,481	1,163
X	19,255	7,203	12,452	6,382
Y	19,345	7,367	5,000	5,429
Z	6,191	4,393	21,312	1,735
AA	5,904	1,721	1,380	1,570
BB	14,963	4,470	4,381	3,382
CC	11,657	3,383	7,681	1,918
DD	13,575	3,670	2,759	2,990
EE	8,064	3,261	8,452	2,974
FF	287	121	830	90
GG	937	211	10	302
HH	5,859	1,480	185	2,204
I I	13,257	4,031	1,223	4,334
JJ	2,582	755	215	1,042
KK	11,702	3,442	508	2,929
Sub-total	397,395	132,189	113,931	138,556
Other	122,605		29,268	41,273
Maricopa Co.	520,000		143,199	179,829

tabulating headquarters in St. Louis, Missouri. Tabulations of resident and non-resident inter-zonal trips by purpose classifications have been prepared. A detailed work schedule for the machine processing phases of the project have been furnished you and other members of your Coordinating Committee.

Preparation of Street and Highway Plan

Preliminary engineering studies were continued as follows:

1. PRELIMINARY RECONNAISSANCE - Preliminary reconnaissance studies of possible freeway-expressway route corridors and major street extensions were continued in February. Tentative route corridors are under study, which are to be modified as the studies progress. The tentative master plan of major streets and highways cannot be finalized until the 1980 land use plan for the Phoenix-Maricopa County Area is received and evaluated with respect to transportation needs. It is understood that this plan will be available during the first week of March. The objective of these preliminary route location studies is to establish a tentative system of inter-connected, high-capacity, high-speed limited-access facilities augmented by a network of major arterials and feeder routes, and a tributary system of collector streets. Assignments of projected 1980 traffic to this tentative network will then be made to determine its adequacy in terms of balanced traffic capacity and service to principal areas of traffic generation.

   Available plans for major street and highway improvements, reports on studies of other civic improvements which may affect major highway route locations, and other technical information concerning major street and highway planning have been collected.

2. BASE MAPS AND PHOTOGRAPHY - An agreement with "Aerial Mapping Company" of Phoenix and Boise, Idaho, was consummated to fly about 1,200 square miles of the greater Phoenix area and to furnish us with aerial photographs at a scale of 600 feet to the inch. A mosaic of the area at a scale of 2,000 feet to the inch is also to be furnished. The up-to-date mapping thus made available will provide information in this rapidly expanding area not otherwise available. The aerial photography may also have many other uses to local officials. It is expected that the completed work will be delivered to us on March 9, 1959.

   Complementing the photo enlargements of the Phoenix-Maricopa County Area which will be used as base maps to indicate recommended major route improvements, available base maps of the area at the same scale are in the process of being provided by the State Department of Highways, as previously requested. Very comprehensive mapping coverage of the area of the study is now available to us for more detailed engineering studies.

3. MAJOR IMPROVEMENTS ALREADY PLANNED - Two major routes in the Phoenix area have been selected for development to freeway standards by 1975 as part of the National System of Interstate and Defense Highways. These include a north-south route - the Black Canyon Highway - and an east-west route passing south of the downtown area. Preliminary plans and profiles for the Phoenix Interstate Freeway have been provided us by the Arizona State Highway Department from the east-west Interstate Route to Solano Drive (south of Bethany Home Road). Plans and profiles for the east-west Interstate Route from the Black Canyon Interchange to Seventh Avenue are also available. The results of a detailed economic impact study of alternate routes for the east-west Interstate freeway are to be provided by the Arizona State Highway Department within the next few weeks. We are advised that general routes and design of the Interstate Highway System in the Phoenix-Maricopa County Area have been established.

Other major improvements planned for the area include those included in the 1958-1959 Proposed Federal Aid Urban Arterial Street Construction Program of the City of Phoenix. About $6,100,000 is to be expended for improvements of various types at about 30 locations, most of which are on section line streets and avenues. Many of the improvements involve arterial street widenings to 64 foot roadway standards (4 lanes with parking).

Typical Roadway Cross-Sections

Preliminary studies of typical roadway cross-sections for facilties of various types have been made. These typical cross-sections are shown in Figure 11, for discussion purposes, comments and suggestions. Unit construction costs have been determined, from which the costs per mile for typical roadway sections will be estimated.

Schedule

A time schedule for completion of the traffic projections of traffic assignments to a tentative major street and highway network has been prepared. Based on this time schedule, this phase of the work will have been completed by the May 12 meeting with the Coordinating Committee if population and land-use projections are furnished by March 1, 1959. We estimate that the project is about 25 percent completed, based on the estimated costs of various work items.

Respectfully submitted,

WILBUR SMITH & ASSOCIATES

G. L. Drake

GLD:cc/pc