

CALIFORNIA

HIGHWAYS AND PUBLIC WORKS



JULY-AUG.
1945

inches

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D50 Illuminant, 2 degree observer

1	39.12	65.43	49.87	44.26	55.56	70.82	63.51	39.92	52.24	97.06	92.02	87.34	82.14	72.06	62.15
2	13.24	18.11	-4.34	-13.80	9.92	-33.43	34.26	11.81	48.55	-0.40	0.80	-0.75	-1.06	-1.19	-1.07
3	13.07	18.12	-22.28	22.85	-24.48	0.35	39.29	-46.07	18.51	1.13	0.23	0.21	0.43	0.28	0.19
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Density

0.04 0.09 0.15 0.22 0.36 0.51

Golden Thread

16	16 (A)	49.25	38.62	28.86	16.19	8.29	3.44	31.41	72.46	72.95	29.37	54.91	43.96	82.74	52.79	50.97
17	17	-0.16	-0.18	0.54	0.80	-0.51	-0.23	20.98	-24.45	16.83	13.06	-38.91	52.00	3.45	50.98	-27.17
18	18 (B)	0.01	-0.04	0.00	0.19	0.49	0.43	19.43	55.93	60.00	45.49	30.77	50.61	81.29	12.72	52.48
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Centimeters

Colors by Munsell Color Services Lab

Don Williams

CALIFORNIA HIGHWAYS AND PUBLIC WORKS

Official Journal of the Division of Highways, Department of Public Works, State of California

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K. C. ADAMS, Editor

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Study Shows Accidents on Arroyo Seco Parkway are Less Than on Some Los Angeles City Streets

By R. E. PIERCE, Principal Highway Engineer

THE elimination of pedestrian deaths and intersection accidents, and a considerable reduction in motor vehicle accidents involving injuries and fatalities between intersections, is shown by a recent study of accidents for the four years from 1941 to 1944, inclusive, on the Arroyo Seco Parkway between Los Angeles and Pasadena as compared with Los Angeles city streets of comparable traffic volume.

The accompanying table shows various accident items all based on million vehicle miles for the years 1941 and 1944. For purposes of comparison these years were selected because 1941 was the last prewar year and 1944 the last available war year.

It is obvious that the Arroyo Seco Parkway with its built-in features of three traffic lanes on each side of a curbed raised central dividing strip, with good standards of alignment, no street or railroad crossings at grade, no pedestrians, and turning movements across traffic eliminated, is more convenient, comfortable and economical for motor vehicle operation than city streets of comparable traffic volume without these features. These same

built-in features also increase the safety of traffic. Just what has been accomplished in the reduction of accidents and added convenience, however, has not heretofore been compiled in actual comparable terms.

A glance at the accident rates per million vehicle miles in the table shows that the rates for the Arroyo Seco Parkway and Riverside Drive (which is in effect an undivided freeway) are quite similar, but all the rest are much higher for both years.

Riverside Drive has certain features in its design differing from the Arroyo Seco Parkway. These are:

- (1) No outer curbs, which gives traffic more freedom of movement;
- (2) Improved shoulders, allowing disabled cars to park clear of the roadway; and,
- (3) In addition to there being no intersecting or cross streets there are no access connections such as the parkway has.

These features may explain to some extent the slightly lower rates for Riverside Drive which we find in the table, especially in the "All Fatalities" column, for both years.

A study of the causes for accidents on the parkway shows that a few approaching accidents occurred due to illegal movement of cars traveling in the wrong direction. Other accidents were caused by cars striking curbs, ramp dividers and disabled vehicles parked on the traveled way.

Consideration of the causes for these types of accidents will result in design changes in future freeways, which should eliminate a considerable proportion of these types of accidents and make the future freeways show an even better accident record.

The rates shown at the bottom of the table for all California Rural State Highways, are not comparable with city street rates, but are interesting as they show that the rates for the Arroyo Seco Parkway and Riverside Drive are much lower, in spite of the much heavier traffic they carry, when compared with the rural State highways as a whole.

Time saving, previously mentioned, is an important factor on the parkway; this was verified by making test runs with an automobile "floating" with the traffic in order to get as near the average speed of the traffic as possible.

A Comparison of Accidents 1941 and 1944 Per Million Vehicle Miles

Location	Average Daily Traffic	Injuries and Fatal Accidents		All Injury and Fatal Accidents		All Injuries	All Fatalities	Pedestrian Fatalities	2 Car Accidents— Course of Vehicles		
		Day	Night	All	All				Approach- ing	Overtak- ing	Intersec- tion
1941											
Arroyo Seco Parkway.....	27,234	0.139	0.347	0.486	0.555	0.035	----	0.052	0.156	----	
Riverside Drive	27,119	0.202	0.289	0.491	0.722	0.029	----	0.173	0.173	----	
Figueroa Street— Manchester Ave. to Vernon Ave.....	25,090	2.184	2.256	4.440	5.335	0.322	0.251	1.146	1.110	1.074	
Figueroa Street— Vernon Ave. to Washington Blvd.....	32,207	1.258	1.664	2.922	3.181	0.074	0.074	0.444	0.444	1.073	
Wilshire Boulevard	39,300	1.095	1.444	2.539	3.421	0.045	0.045	0.623	0.912	0.319	
State-Rural State Highways.....	----	----	----	1.174	1.993	0.145	0.036	0.361	0.301	0.241	
1944											
Arroyo Seco Parkway.....	21,488	0.176	0.198	0.374	0.549	0.044	----	0.017	0.087	----	
Riverside Drive	21,404	0.146	0.256	0.402	0.805	----	----	0.146	0.073	----	
Figueroa Street— Manchester Ave. to Vernon Ave.....	19,368	1.391	2.319	3.710	5.566	0.092	0.046	0.464	1.484	0.788	
Figueroa Street— Vernon Ave. to Washington Blvd.....	20,873	1.293	1.533	2.826	3.689	0.096	0.096	0.527	0.910	0.383	
Wilshire Boulevard	31,389	1.088	1.258	2.346	3.285	0.056	0.038	0.375	0.901	0.319	
State-Rural State Highways.....	----	----	----	0.986	1.678	0.136	0.041	0.330	0.310	0.410	



Traffic is safely handled on Arroyo Seco Parkway with divided lanes, overheads and on and off ramps

These test runs taken during the heavy traffic periods, 4 to 6 p.m., on the parkway and city streets gave the following results:

**ARROYO SECO PARKWAY—
5.80 MILES**

From San Fernando Road, Los Angeles, to Glenarm Street, Pasadena. Average speed 40.2 m.p.h.

RIVERSIDE DRIVE—3.50 MILES

From Los Feliz Boulevard to Hollingsworth Drive. Average speed 40.1 m.p.h.

In contrast, test runs made on Figueroa Street and Wilshire Boulevard gave the following results:

FIGUEROA STREET—5.35 MILES

From Manchester Avenue to Washington Boulevard. Average speed 17.2 m.p.h.

**WILSHIRE BOULEVARD—
4.65 MILES**

From East City Limits of Beverly Hills to Vermont Avenue. Average speed 23.3 m.p.h.

During periods of light traffic the speed on the freeways could be considerably increased without serious hazard, but on the other streets due to the many stops on account of traffic signals the speed could increase very little.

Accident records for the four years 1941 to 1944 inclusive were collected in this study. The total accidents on the streets used in this study involving injuries and fatalities for these years are as follows:

Arroyo Seco Parkway	114
Riverside Drive	102
Figueroa Street—Manchester Avenue to Vernon	511
Figueroa Street—Vernon to Washington	309
Wilshire Boulevard	710

This further emphasizes the advantage of the freeway type of highway.

The streets used in this study were: Riverside Drive from Los Feliz Boulevard to Hollingsworth Drive; Figueroa Street from Manchester Avenue to Washington Boulevard; and Wilshire Boulevard from east city limits of Beverly Hills to Vermont Avenue.

Herewith are brief descriptions of the Arroyo Seco Parkway and the three streets.

ARROYO SECO PARKWAY

That portion from San Fernando Road to South City Limit of Pasadena, 5.80 miles.

The pavement on each side of the curbed dividing strip is 35 feet wide between curbs, each divided by two traffic stripes into three lanes, the center lane 11 feet in width, the two outer lanes 12 feet wide. The portion from San Fernando Road to the west-

erly city limits of South Pasadena (4.30 miles) is provided with lighting units on arms projecting from standards along the outside curbs. The balance through South Pasadena (1.50 miles) is unlighted.

At appropriate and convenient locations, inlets and outlets are provided by means of one-way roads or ramps with widened pavement at these points for blending with or withdrawing from the faster moving traffic on the main freeway.

Parking on the main freeway is prohibited, as are pedestrians.

RIVERSIDE DRIVE

From Los Feliz Boulevard to Hollingsworth Drive, 3.50 miles.

This stretch of road is a 40-foot four-lane undivided asphalt pavement with oiled shoulders four to six feet wide. It is divided into four 10-foot lanes by a double center stripe and a single stripe 10 feet each side of this center stripe. Situated as it is along the western bank of the Los Angeles River and

with no intersecting streets, it is in effect an undivided freeway and was selected for that reason. Small, widely spaced lights along one side of the road add very little to improve visibility at night. Parking is prohibited throughout.

In addition to having no intersecting or cross streets it also has no inlets or outlets which the Arroyo Seco Parkway has.

FIGUEROA STREET

From Manchester Avenue to Washington Boulevard, 5.35 miles.

That portion from Manchester Avenue to 37th Street runs practically due north: at 37th Street there is about a 30° angle northeast.

The pavement is asphaltic and is 66 feet in width between curbs. There is a double painted white stripe in the center and a single painted white stripe 10 feet each side of the center stripe. Parallel parking in an 8-foot width is permitted for the entire distance between Manchester Avenue and Wash-

ington Boulevard. This marking provides four lanes, the outer lanes being 15 feet wide between the outside stripes and the parking lane.

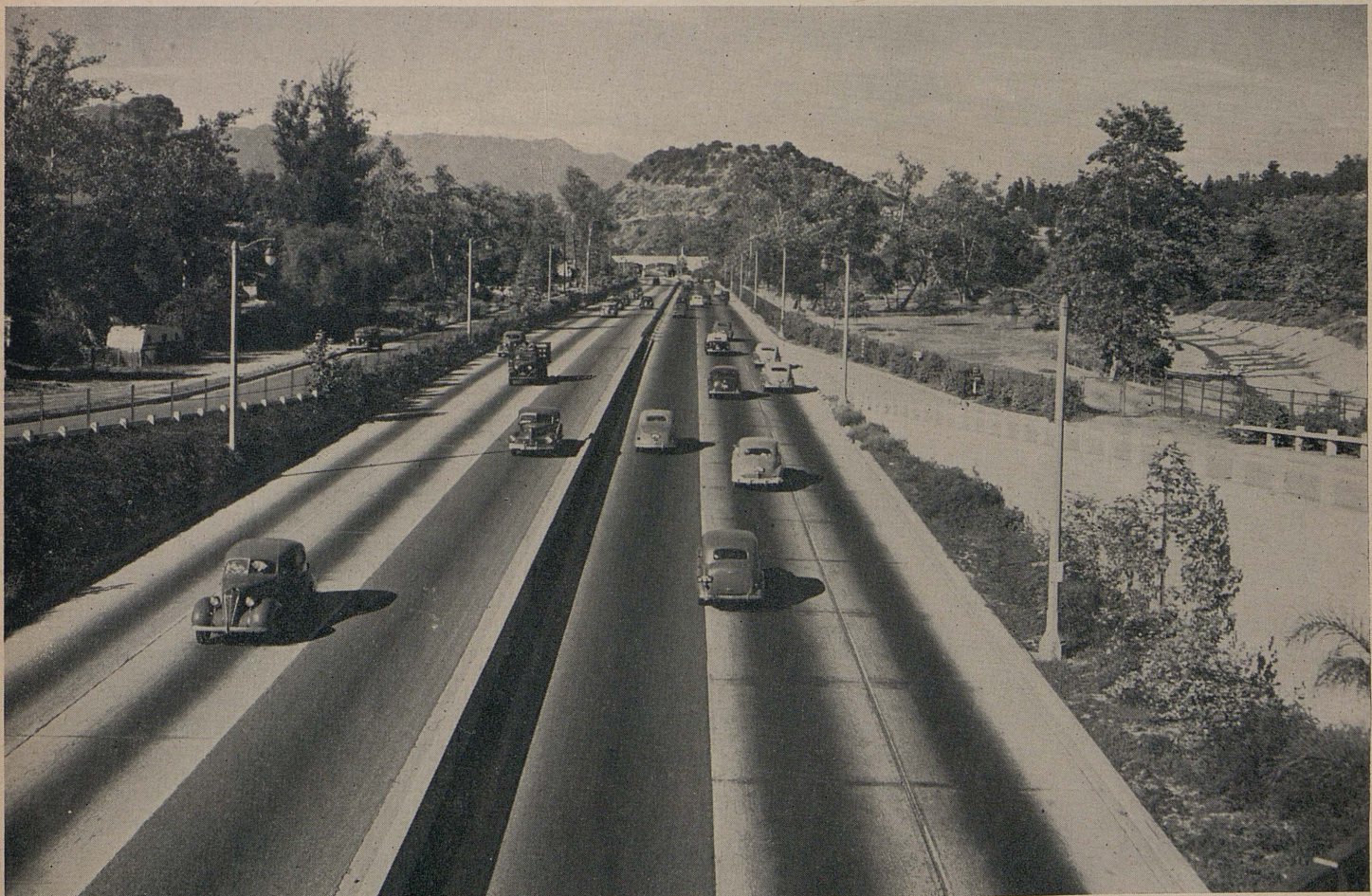
Lighting: From Washington Boulevard to Vernon Avenue, a distance of 2.30 miles, the lights are on the old style cast iron standards placed along the curb with two light units. From Vernon Avenue to Slauson Avenue, a distance of about one mile, single arc lights are suspended over the centers of the intersections.

From Slauson Avenue to Manchester Avenue, the light standards are similar to those between Washington Boulevard and Vernon Avenue, but only one of the light units are lighted. Hence for this study we have divided Figueroa Street into two parts: (1) the better lighted section from Washington Boulevard to Vernon Avenue, 2.30 miles; and (2) the poorer lighted section from Vernon Avenue to Manchester Avenue, 3.05 miles.

Nineteen intersections are controlled by automatic signals; of these four are the three-light type, the balance being

(Continued on page 30)

Riverside Drive is a typical undivided freeway



HIGHWAYS OF CALIFORNIA

By J. D. GALLAGHER, Associate Highway Engineer

OF the 48 States none holds greater variety in terrain and climate than may be found in the 159,000 square miles of California. Extending about 200 miles inland from the Pacific along some 800 miles from Mexico to Oregon, the State encompasses almost all that there is in the way of temperate climate and geologic formation.

The coast line varies from wide beaches to rocky bluffs and headlands. The broad valleys of the Sacramento and San Joaquin present typical mid-western agricultural land, hemmed in by the semibarren Coast Range on the west and the towering snow-capped Sierra on the east. The drifting sand dunes of the great Mojave Desert are arid in the extreme, while in the redwood country adjacent to the north coast the annual rainfall is 70 inches and more. The rugged terrain of southern portions of the State is broken with fertile valleys, green with citrus groves. The Imperial Valley, in the extreme southern portion of the State consists of a millenium of silt deposits upon an ancient ocean floor made productive by water from the Rockies a thousand miles away.

Joining these diverse sections into a unit are the 14,000 miles of road in the California State Highway System. Spreading over the State, this network of highways is composed of main arteries running north and south with major laterals to the east and west. Stemming from these principal routes are the secondary roads acting as traffic feeders.

MANY PROBLEMS

Development and maintenance of these State highways, traversing desert, mountains, valleys and coast of California, present problems of such variety as to challenge engineering ability and practice.

By the average motorist, modern highways are taken for granted. Travel over bridges and mountains, through tunnels and passes is accomplished with little or no thought of obstacles overcome in their construction and maintenance. A few moments over a bridge that was many months in erection; a few seconds through a tunnel which took a year or more to bore;

a few hours, and an entire mountain range is crossed, the same range which took "'49'ers" weeks to overcome—all are traveled with such speed and comfort that it would seem their construction must have been simple.

The factual data behind the stories of the development of the various routes in the California State Highway System are many and varied. Some reveal victory over seemingly insurmountable obstacles of nature; others are interwoven with the romance which was early California, and still others are the prosaic story of just keeping everlastingly at it. It might be that motorists could more appreciate their travels along California's highways if they were familiar with the stories behind them.

REDWOOD HIGHWAY

For many years construction and maintenance operations on the Redwood Highway (U. S. 101 north of San Francisco) have been complicated by numerous frequent slides and slipouts through the mountainous areas of heavy rainfall along the northern coast country. The same extreme in moisture, which during the past 2,000 years has produced the famous groves of towering redwoods, has made provision of stable foundations most difficult and unique methods of engineering practice are frequently necessary to meet the problems of saturated subsoils.

An example of unusual construction practice on this route occurred in 1934 on the relocation of nine miles between Last Chance Slide and Flannigan's just south of Crescent City in Del Norte County. This revised alignment followed a line back from the ocean shore and through relatively dense redwood growth. While every effort was made to preserve the groves it was necessary to fell a few large trees ranging to 17 feet in diameter and rising to from 250 to 300 feet into the sky. At that time, commercial disposition of the trees in the vicinity was impractical, so with the knowledge that redwoods, even though buried, will remain for decades in a remarkable state of preservation, decision was

made to use the timber in construction of roadway fills.

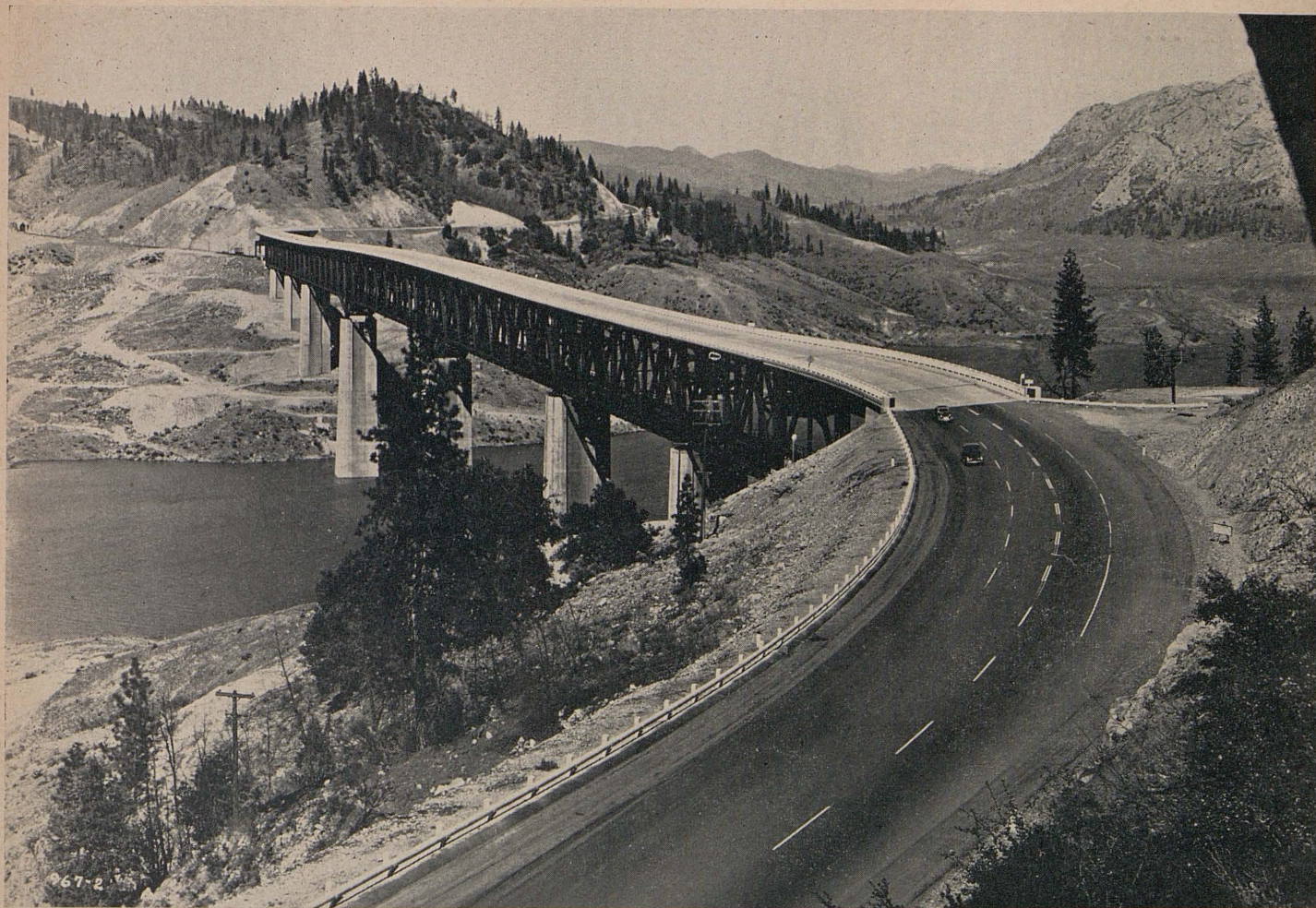
The felled trees were cut into convenient sizes and nearly 10,000,000 board feet of timber were used in fill construction providing the equivalent of more than 30,000 cubic yards of earth embankment. By elimination of long shallow fills adjacent to the redwood embankments the area occupied by them was much less in extent than would have been required by a conventional earth fill.

FLOOD DAMAGE

The appellation of "Redwood Highway" to this route is doubly applicable to this section in Del Norte County.

Back in 1922, the State was constructing a triple reinforced concrete arch bridge on the Redwood Highway across the Van Duzen River in Humboldt County, paralleling a bridge of the Northwestern Pacific Railroad. The river was practically dry and traffic was being routed over a small temporary timber structure. On October 25th it started to rain and in a few days Humboldt County experienced the heaviest storm of 76 years. On the morning of October 28 the flooded river carried out the temporary detour bridge. Traffic was then routed over an old county bridge, but it was washed away that afternoon.

Permission was immediately secured from railroad officials to lay a temporary floor on the railroad bridge and use it for a detour crossing. By 1 o'clock on the afternoon of October 29th the first truckload of lumber was delivered to the bridge and at 8 a.m. on November 1st the first automobile crossed the railroad bridge. Gates were built on the approaches, temporary semaphores were erected and deputy sheriffs and railroad flagmen placed to control traffic. Members of the Highway Commission signed waivers releasing the railroad from all liability and in turn those using the bridge were required to sign waivers in favor of the commission. As soon as the flood subsided a single-lane pile bridge was built across the river for the detour traffic and the use of the railroad bridge discontinued. Approximately 1,000 feet of the bridge was flooded, using some 53,000 feet of lum-



This is the Pit River Bridge which carries State Highway across Shasta Dam Lake

ber, with another 10,000 feet used in the approaches.

GOLDEN GATE BRIDGE

The Redwood Highway has its southerly terminus at San Francisco, crossing the historical Golden Gate on the longest single suspension span bridge in the world. This monumental structure across the entrance to San Francisco Bay was constructed by the Golden Gate Bridge and Highway District between 1932 and 1937. The total length of the bridge and approach structure is 8,981 feet, the length of the suspended structure is 6,450 feet, and the length of the main span is 4,200 feet. The towers which support the two 36-inch cables rise 746 feet above the water.

Building the Marin County approach to the Golden Gate Bridge presented some unusual construction problems. This section of the Redwood Highway traverses coastal mountain slopes for the greater portion of the 3.6 miles from Waldo to the bridge. While

the terrain is rough and construction involved cuts and fills up to 200 feet in vertical depths, the usual attendant difficulties of such work were increased by the lack of even average mountain stability. The excavation and slides which developed required the moving of more than 2½ million cubic yards of material. The project required a tunnel near the crest with a length of 1,000 feet and a bore 29 feet in height and 46 feet in width. Construction of this four-lane approach to the Golden Gate Bridge cost approximately \$2,000,000.

SHASTA DAM RELOCATION

The construction of Shasta Dam, the largest unit of the great Central Valley water and power project required relocation of 19.5 miles of State Route 3 (U. S. 99), as well as many miles of railroad, through rough, forbidding mountainous terrain over which earlier locators did not have the temerity, nor the need, to build.

Here was a situation of concurrent construction almost unique in highway-

railroad relations. The more lenient and elastic limitations permitted by the motor vehicle required that the highway bow to the more stringent railroad standards, wherever the two conflicted. In relocation of the two transportation facilities, highway and railroad cross and recross five times, with only one a conventional grade separation structure. Three occur over tunnels deep in the mountain side, and the fifth takes place at the common crossing of the Pit River, where the highway uses the upper deck and the railroad the lower of a \$5,000,000 steel bridge.

HEAVY GRADING

The highway portion of this project contains some of the heaviest grading ever undertaken on two-lane construction in Northern California: with a total of 2,850,000 cubic yards of excavation; 726,000 cubic yards in one mile, with cuts up to 275 feet and fills as high as 289 feet.

Notwithstanding more difficult topography, the new route, opened to traffic

on January 8, 1943, is safer, faster, and almost four miles shorter than the old road. Its most outstanding unit is the massive Pit River Bridge, a 3,588-foot, eight-span, double-deck steel structure. This bridge, built by the Bureau of Reclamation which supervised construction of the dam, provides a four-lane crossing for the highway on its upper deck 530 feet above the river bed; and on the lower deck, a double track for the railroad. While two of its massive concrete piers are among the highest in the world, more than 350 feet, they will barely emerge from the high level of the lake which is being formed by the dam.

Dwarfed only by comparison with its bigger sister is the 1,330-foot, seven-span bridge across the Sacramento River at Antler, near the northern end of the new location. This structure, designed and built by the Division of Highways, is interesting because of its complicated design on both vertical and horizontal curves.

FEATHER RIVER HIGHWAY

Carved out of solid rock, hewn through granite cliffs, criss-crossing mountain streams, the Feather River Highway is another thrill for the sight-seeing motorist, as well as a joy and comfort to the Plumas County highlanders. But more than this, the road stands as a monument to the intrepidity of the locating engineer, the skill of contractors and the dogged effort of labor.

The Feather River Highway is the only road over the Sierra that avoids the heavy snow area of the higher altitudes. Throughout most of its length it follows easy river gradients. Such a road has many advantages, but easy construction and low initial cost are not among them. It took more than nine years to build and cost well over \$7,000,000, almost \$100,000 per mile, and nearly 8,000,000 cubic yards of material, 85 per cent of which was solid rock, were moved in its making.

Natural obstacles to the location of a highway through this rugged country of steep canyon walls and glacier-polished precipices were as formidable as ever confronted the locating engineer. These were complicated by man-made barriers: a transcontinental railroad, powerhouses, transmission lines, and future power reserves. The railroad, built almost 40 years ago, naturally had taken the easiest route, and the highway had to make the best of what



One of many beautiful sections of Redwood Highway (U.S. 101)

was left, leaping across the canyon as the railroad crossed oppositely below or playing hide-and-seek around and over tunnels.

THREE TUNNELS BORED

For 10 of the most difficult miles, the road follows a niche cut in the solid wall of the canyon. Three tunnels pierce the most precipitous projections under Arch Rock and through Grizzly Dome, a huge, bowl-shaped mass of bare granite which rises starkly for 1,000 feet above the river.

At Pulga, a 350-foot steel arch joins rocky cliffs of the canyon 200 feet above the river straddling and dwarfing the railroad bridge that crosses at right-angles 170 feet below.

The entire route along the Feather River between Oroville and Quincy is one of natural beauty—pine covered mountain sides punctuated with masses of granite—a section in the California State Highway System which creates an everlasting impression.

SAN FRANCISCO-OAKLAND BAY BRIDGE

The \$70,000,000 San Francisco-Oakland Bay Bridge is by far the biggest single project ever undertaken by the Department of Public Works, and rightfully is the most renowned. Spanning 4½ miles of navigable water between the two metropolitan areas, its spectacular construction progressed in

full view of thousands of city dwellers and commuters who gained thereby an appreciation of the immensity of the task. But after eight years even the former "ferry-rail superintendents" who now travel the bridge, secure in fog and storm, seldom recollect that this mighty structure took six years to complete or that it holds many world-wide records, foremost among them: the greatest length, the deepest piers, and the largest vehicular tunnel bore.

The west crossing between San Francisco and Yerba Buena Island, is unique for its twin suspension spans, held by a common anchorage in mid-channel. The wire in the 28 $\frac{3}{4}$ -inch suspension cables would encircle the earth nearly three times. Its towers reaching as high as 519 feet above water and its piers as much as 242 feet below the surface would overtop a 60-story skyscraper. The 540-foot tunnel through Yerba Buena Island was bored 76 feet wide and 58 feet high to provide for the double-deck construction. The east crossing, between Yerba Buena Island and Oakland, is a steel bridge, the main cantilever span 1,400 feet long. The total length of the bridge from the San Francisco terminal, to the toll plaza at the Oakland end is 8 $\frac{1}{4}$ miles.

HUGE AMOUNT OF MATERIALS

Building the bridge required materials in quantities rarely encountered in a single structure. Over 152,000 tons of structural steel were erected, 30,000 tons of reinforcing steel was placed and the suspension cables required 18,500 tons of wire; the concrete amounted to 1,000,000 cubic yards which required 1,300,000 barrels of cement; 30,000,000 board feet of timber and lumber were used and it took 200,000 gallons of paint to cover the bridge.

To the construction of the bridge even prehistoric animals contributed their bit—or rather their all—yielding their final resting place to make room for the piers; dredges reached into prehistoric time in excavating for their foundations, pulling a mastodon's tooth and an ancient bison's bones from the ooze 180 feet below the bottom of the bay.

Along with the Golden Gate Bridge, Boulder, Shasta, and Grand Coulee dams, the San Francisco-Oakland Bay Bridge stands out as one of the foremost structures in the west.

SANTA CRUZ LATERAL

Modernization of the scenic route across the redwood covered Santa Cruz

Mountains between Los Gatos and the shore line at Santa Cruz has been another undertaking of the first magnitude. The original highway, one of the old "County seat laterals" provided in the State bond issue of 1909, was considered a bold location for its time but, typical of mountain roads of the early days, its tortuous alignment and narrow width became more and more obsolete with the years as traffic speed and volume increased.

Connecting the densely populated San Francisco Bay area with attractions of the Santa Cruz and Monterey coast lines, this is one of the most heavily traveled recreational highways in the State. Those who remember the congestion and dangers on the old two-lane route, when holiday motorists crawled at a snail's pace or risked their lives in passing other cars, can best

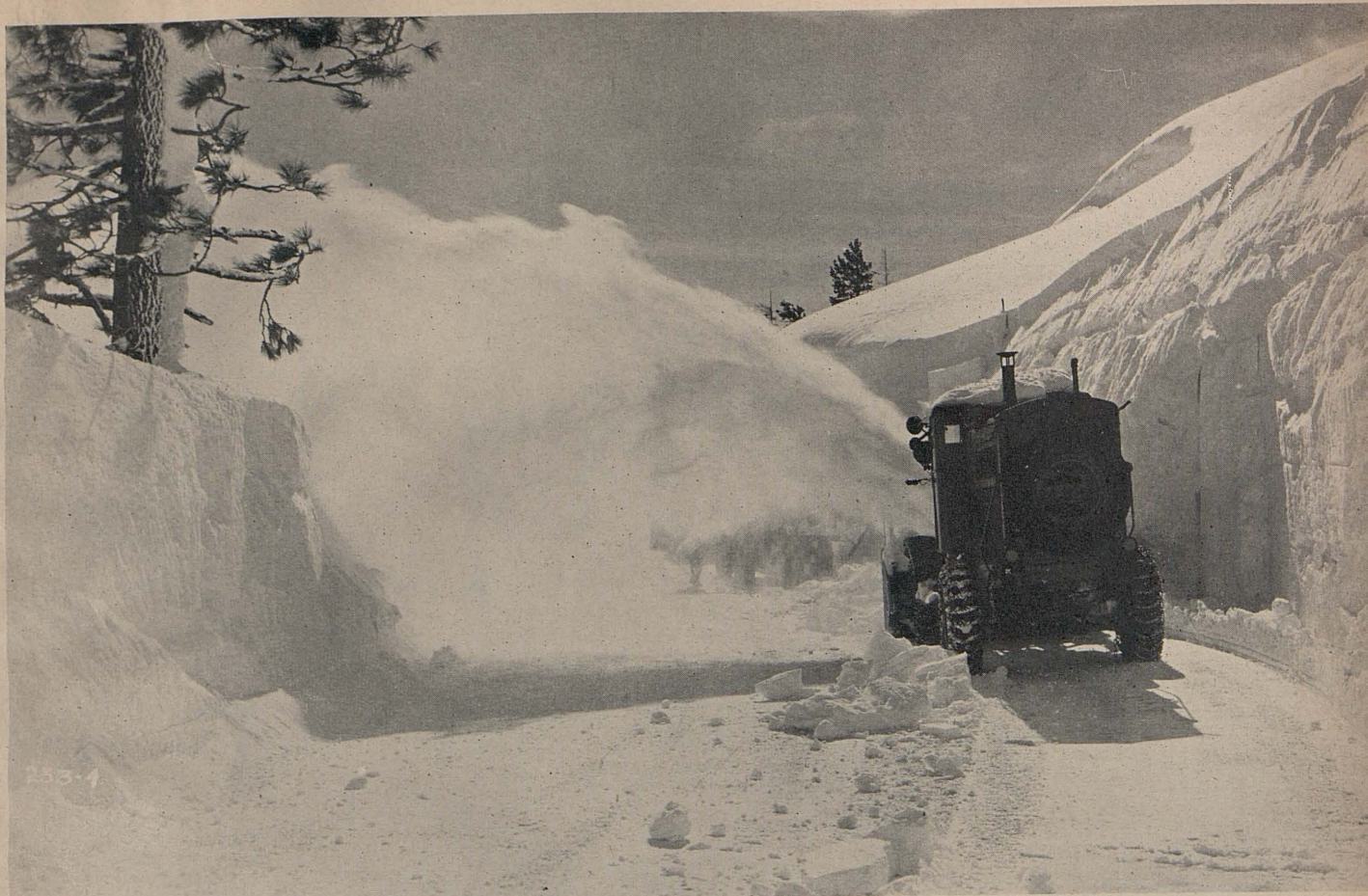
appreciate the modern four-lane highway through the heavy mountain sections and three lanes through the valleys and flats. Through the heart of the mountains traffic now travels 13 miles of modern alignment with but 42 easy curves instead of 16 $\frac{1}{2}$ miles of dizzy serpentine of 284 sharp curves, a difference in total curvature equivalent to 36 full circles.

STAGE CONSTRUCTION

The 20.6 miles of new construction (five miles shorter than the old road) progressed by stage construction over a period of 9 $\frac{1}{2}$ years from 1931 to 1940. It involved 11 road and bridge contracts totaling approximately \$3,000,000, one of them the largest grading contract ever undertaken by the Division of Highways—more than 2,500,000 cubic yards in 6 $\frac{1}{2}$ miles.

One of the unusual features on the Feather River Canyon Highway is the overcrossing by the State Highway Bridge of the Western Pacific Railroad Bridge at Pulga





Snow removal equipment of Division of Highways in operation on Donner Summit

Unusual construction problems in this development and their solution commanded the interest of highway circles throughout the Nation. Treacherous ground conditions and proximity to the San Andreas fault line, which the highway crosses, required rigorous foundation treatment in construction of heavy fills. This work involved such practices as stripping the earth blanket to bedrock and replacing with imported rock base; constructing heavy rock toe-walls for fills; and most extensive trenching and sub-drains. At one section, through narrow Los Gatos Creek Canyon, the highway was squeezed between the steep slope of the mountain and a railroad at the bottom. In this location, two of the four lanes are carried on a reinforced concrete and steel pile sidehill viaduct for a distance of about 1,000 feet.

To thousands of motorists this route provides easy access from the Santa Clara Valley at the southerly end of San Francisco Bay to mountain resorts among the redwoods or on to the beaches at Santa Cruz and its neighboring Capitola, as well as a pleasant

way of reaching Carmel and the Monterey Bay area.

CARMEL-SAN SIMEON HIGHWAY

Along the California Coast, the Shoreline Highway offers 450 miles of most beautiful scenery. However, the very topographic features which make the charm of this rugged coast line presented survey parties and construction crews with some of the most dangerous and difficult work ever experienced by Division of Highway forces. From the redwood country of Mendocino County, this route follows the ocean shore, past settlements founded by the Russians early in the nineteenth century, to San Francisco, and on to the south through historic Monterey to one of the Franciscan Fathers' earliest missions in San Luis Obispo.

Much of the present State highway is a relocation of earlier routes which have led a precarious existence, literally "between the devil and the deep, blue sea"—the devil of slides and erosion on one side, and the menace of the ocean's fury on the other. A short por-

tion in San Mateo County was built upon the bed of the abandoned Ocean Shore Railroad; but 68 miles of the southerly portion, from beautiful Carmel to sinister Morro Rock, represent pioneer construction through one of the wildest and most precipitous sections of the entire coast.

COST \$9,000,000

This latter portion was 16 years in building (1921-1937) and cost \$9,000,000. It required the removal of 13,000,000 cubic yards of material; one massive promontory alone, Limekiln Bluff, yielded 163,000 yards—97,000 in a single blast. The lack of stability of the rock formations of these coastal ridges was a source of much difficulty in the highway's construction. Severe and sudden slides threw tons of material into the ocean at the foot of the bluffs. One such slide carried a contractor's large power shovel with it into the pounding surf.

Thirty-two bridges were required to span the numerous gorges which empty into the ocean along this coastal country, five of them being graceful arches.

(Continued on page 28)

Federal Aid Secondary Roads to be Given Exclusive Attention

By H. B. LA FORGE, Engineer, Federal Secondary Roads

THE Federal-Aid Highway Act of 1944 provides in part for the expenditure of \$150,000,000 a year for each of three successive post-war fiscal years for construction upon a system of Federal Aid secondary roads.

It is generally believed that the above act as it relates to an expanded Federal Aid System is of a permanent nature and that Congress will continue to evidence an active interest in secondary roads in the form of regular appropriations. For this reason and because of the increased detail involved, a new section of the Division of Highways has been formed to devote its exclusive attention to this phase of highway work.

GRADUAL DEVELOPMENT

Looking back 25 years we find the foundation being laid for the present Federal Aid System, in the careful selection of our main interstate and intrastate highways. We have seen the gradual development of that system and realize that its component parts were indeed selected with care. This is evidenced by the present vast highway passenger and transport movement which had its beginning in the selection and improvement of the principal traffic arteries.

It is evident that the same care should be exercised in the selection of the Federal Aid Secondary System so that an orderly and progressive program of construction will provide rural areas with proper access to economic and social contacts such as markets and shipping points for farm products, postal service and schools. This secondary system, together with the parent system, are intended to complement each other as trunk line and feeder routes and will, therefore, be interconnected. It necessarily follows that in considering roads for inclusion in the secondary system, no distinction can be made between county roads and roads which are State highways.

There is no fixed maximum for the mileage which may be included in the secondary system, however, the govern-

DISTRIBUTION TO COUNTIES

The following tabulation is presented in order to show the distribution of funds as between counties.

Distribution is based on ratio of the average of Rural Population + Area + Mileage Rural Post and Star Routes in a county to similar factors in whole State. San Francisco City and County has been eliminated from consideration. Alpine, Amador, Del Norte, and Sierra counties have been allocated the minimum of $\frac{1}{2}$ of 1 per cent.

	Federal Funds		State funds	Total allocation
	1 year	3 years		
Alameda.....	\$57,022	\$171,066	\$151,489	\$322,555
Alpine.....	22,585	67,755	60,000	127,755
Amador.....	22,585	67,755	60,000	127,755
Butte.....	74,455	223,365	197,801	421,166
Calaveras.....	27,252	81,756	72,398	154,154
Colusa.....	30,930	92,790	82,170	174,960
Contra Costa.....	65,788	197,364	174,776	372,140
Del Norte.....	22,585	67,755	60,000	127,755
El Dorado.....	39,098	117,294	103,869	221,163
Fresno.....	231,221	693,663	614,273	1,307,936
Glenn.....	36,762	110,286	97,662	207,948
Humboldt.....	83,921	251,763	222,948	474,711
Imperial.....	95,114	285,342	252,684	538,026
Inyo.....	111,949	335,847	297,410	633,257
Kern.....	202,430	607,290	537,785	1,145,075
Kings.....	54,144	162,432	143,841	306,273
Lake.....	30,286	90,858	80,460	171,318
Lassen.....	67,170	201,510	178,448	379,958
Los Angeles.....	462,641	1,387,923	1,229,073	2,616,996
Madera.....	54,939	164,817	145,954	310,771
Marin.....	41,127	123,381	109,259	232,640
Mariposa.....	28,659	85,977	76,136	162,113
Mendocino.....	71,669	215,007	190,401	405,408
Merced.....	77,470	232,410	205,811	438,221
Modoc.....	57,372	172,116	152,416	324,532
Mono.....	40,336	121,008	107,160	228,168
Monterey.....	90,963	272,889	241,658	514,547
Napa.....	39,249	117,747	104,270	222,017
Nevada.....	28,291	84,873	75,159	160,032
Orange.....	86,608	259,824	230,087	489,911
Placer.....	46,489	139,467	123,506	262,973
Plumas.....	44,904	134,712	119,294	254,006
Riverside.....	166,057	498,171	441,154	939,325
Sacramento.....	101,006	303,018	268,336	571,354
San Benito.....	32,412	97,236	86,108	183,344
San Bernardino.....	302,696	908,088	804,156	1,712,244
San Diego.....	131,335	394,005	348,911	742,916
San Francisco.....	-----	-----	-----	-----
San Joaquin.....	105,872	317,616	281,264	598,880
San Luis Obispo.....	71,129	213,387	188,966	402,353
San Mateo.....	40,783	122,349	108,345	230,694
Santa Barbara.....	61,057	183,171	162,206	345,377
Santa Clara.....	103,758	311,274	275,649	586,923
Santa Cruz.....	36,802	110,406	97,770	208,176
Shasta.....	73,631	220,893	195,613	416,506
Sierra.....	22,585	67,755	60,000	127,755
Siskiyou.....	106,323	318,969	282,462	601,431
Solano.....	44,757	134,271	118,903	253,174
Sonoma.....	105,387	316,161	279,975	596,136
Stanislaus.....	90,990	272,970	241,728	514,698
Sutter.....	32,813	98,439	87,174	185,613
Tehama.....	52,901	158,703	140,539	299,242
Trinity.....	47,598	142,794	126,452	269,246
Tulare.....	164,452	493,356	436,890	930,246
Tuolumne.....	39,228	117,684	104,215	221,899
Ventura.....	71,077	213,231	188,825	402,056
Yolo.....	39,885	119,655	105,961	225,616
Yuba.....	26,424	79,272	70,200	149,472
Totals.....	\$4,516,972	\$13,550,916	\$12,000,000	\$25,550,916

ing Federal regulations require a balance of estimated annual funds available for, against estimated annual cost of, maintenance and construction, of the mileage to be included, so as to permit completion of initial improvement within a reasonable period of years. It is estimated that between 7,000 and 8,000 miles can reasonably be included in the system at this time under this provision. This will provide an abundance of mileage in need of construction even in those counties best equipped with good roads. Time and study will determine what additions can reasonably be added.

Since Federal Aid funds require matching by the recipient, it became apparent that a good many counties would stand to gain no benefits to their county roads because of their inability to provide their share of construction costs. Accordingly, the last session of the State Legislature appropriated \$12,000,000 for this purpose under the County Highway Aid Act of 1945. This act also provided that 87 $\frac{1}{2}$ per cent of the Federal Aid secondary funds be expended upon the county road units of the secondary system as fully as permissible under Federal law, rules and regulations.

NEGOTIATIONS WITH COUNTIES

The District Engineers of the Division of Highways have been instructed to resume negotiations with the counties toward the selection of the secondary system. This work was suspended in December of 1944 due to the uncertainty of pending legislation. After studying the new "Regulations" and the previous work of selection, it is found that the system has been practically agreed upon in about half of the counties. It is hoped that this phase of the work will proceed rapidly so as to clear the way for the next step of establishing a program of proposed construction.

The Federal Aid Act sets up all of the machinery for putting the program into effect except the actual appropriation of funds. Since the funds appropriated by the State Legislature are

(Continued on page 28)

Carquinez and Antioch Bridges Became Toll Free on August 1

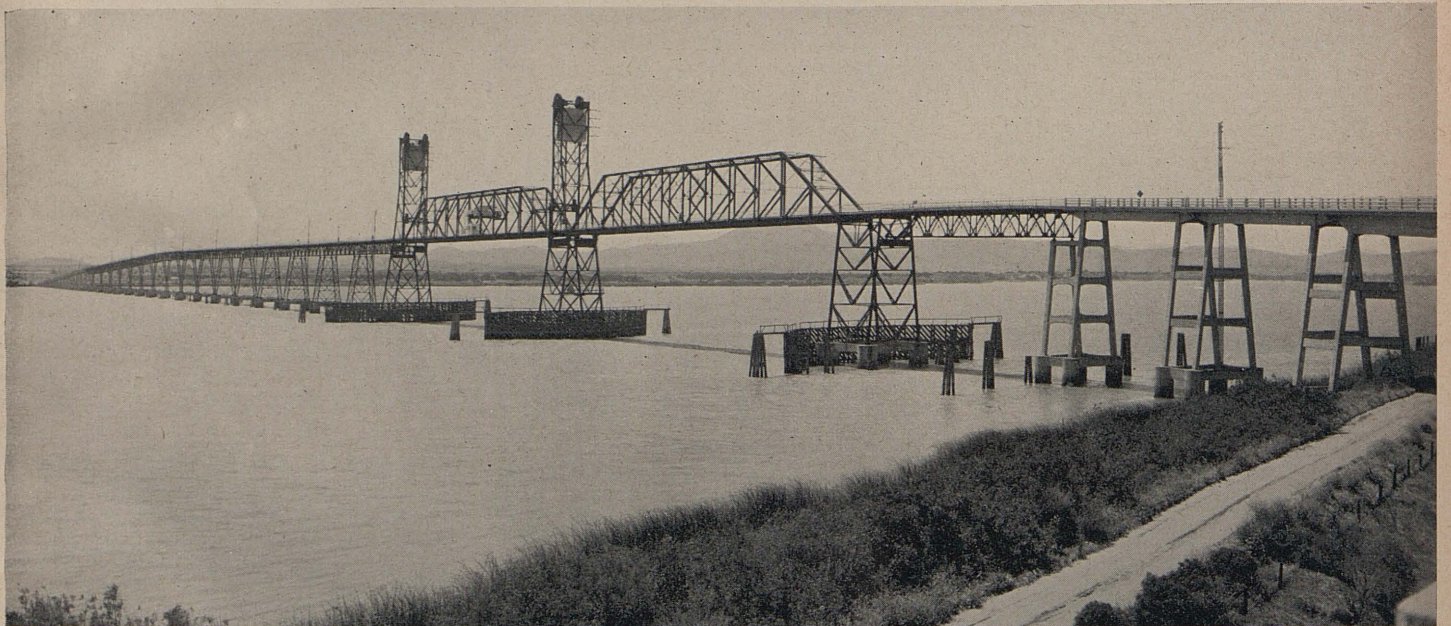
LESS than five years after their purchase by the State on September 16, 1940, the Carquinez and Antioch bridges have been fully paid for and have become toll-free facilities. Toll collection on both bridges ceased at 12.01 a.m. on August 1, 1945, under a directive of the California Toll Bridge Authority proposed by its chairman, Governor Earl Warren. Under the franchises issued by Contra Costa County for the construction of

of 45 cents for the vehicle plus 5 cents per passenger to a flat charge of 30 cents for the vehicle, including passengers. Other tolls were made to approximate, or to reduce slightly, the previous rates.

Substantial reductions were made in truck tolls on December 16, 1940, and again on May 16, 1941. The continued high volume of traffic made it possible to reduce the passenger automobile toll from 30 cents to 25 cents on June 1,

bridge revenues. Maintenance costs paid from the State Highway Fund during this period have been about \$80,000, principally for bridge painting. Franchise and gross revenue taxes totaling about \$169,000 have been paid to Contra Costa, Solano, and Sacramento counties. No property taxes on the bridges have been paid by the State to the counties.

Since December 14, 1941, when an emergency was declared by the Gov-



Antioch Bridge which, with Carquinez Bridge, became toll free on August 1

the bridges, Carquinez Bridge would not have become toll free until March 7, 1948, and Antioch Bridge not until July 4, 1948.

The purchase of the two bridges by the State was financed through a revenue bond issue of \$5,943,000. The entire bond issue has now been retired or called for redemption, sufficient revenue having been collected to pay the entire debt and to furnish a small reserve for certain bridge improvements which have had to be postponed as a result of the war.

Coincident with its assumption of operation of the bridges on September 16, 1940, the State established a new toll schedule, reducing the passenger automobile toll from the previous rate

of 45 cents for the vehicle plus 5 cents per passenger to a flat charge of 30 cents for the vehicle, including passengers. (See California Highways and Public Works, June, 1942.)

State ownership and operation of the Carquinez and Antioch bridges has resulted in substantial savings to the public using the bridges. Just prior to their acquisition by the State, the average toll on the two bridges was about 65 cents per vehicle. Since September 16, 1940, the average toll has been 37 cents, indicating an average saving of 28 cents per crossing. Applying this figure to the 20,750,000 vehicular crossings which have been made since September 16, 1940, the total saving becomes \$5,800,000, which approximates the purchase price of the bridges.

Toll collection expenses and other operating costs have been paid from

error, the armed forces of the State and of the United States have been benefited by the toll-free passage over these bridges of about 675,000 vehicles.

A further saving to the public could be claimed because of the fact that the bridges have become toll free almost three years ahead of the dates set in the franchises. On the basis of the tolls prevailing just before September 16, 1940, this additional saving would probably be in the neighborhood of \$6,000,000.

The elimination of tolls on the Carquinez and Antioch bridges is a concrete fulfillment of the policy of the State of California as expressed in Section 1 of the California Toll Bridge Authority Act.

CALIFORNIA MISSIONS

By KENNETH C. ADAMS, Editor

San Luis Obispo de Tolosa September 1, 1772

IN the Valley of the Bears, so named by Gaspar de Portola and his men on their first expedition from San Diego north in search of Monterey Bay in 1769, Father Junipero Serra on September 1, 1772, founded the Mission San Luis Obispo de Tolosa, fifth in his chain of Franciscan stations.

Progressing slowly on their march northward, Portola and his soldiers encountered many ferocious bears between the mouth of the Santa Maria River and the present site of San Luis Obispo and killed a number of them for food. Father Juan Crespi, whose ability for picking future mission locations was remarkable, accompanied Portola as did Father Francisco Gomez. Both padres left for posterity interesting diaries describing the trip and the discovery of what now is San Luis Obispo. While the soldiers called the valley there the Valley of the Bears, Fr. Crespi named it La Canada de la Natividad de Nuestra Senora because he arrived there on the eve of the Nativity of the Blessed Virgin, September 7, 1769.

As we know, Portola failed to find Monterey Bay and returned to San Diego discouraged and determined to return to Mexico. However, he was spurred on to make another attempt by Fr. Serra and set out again from San Diego on April 17, 1770, while Fr. Serra, Presidente of the California Missions, went with a sea expedition which anchored in Monterey Bay shortly after Portola reached there by land.

BEAR MEAT

Ten Franciscan friars arrived at Monterey from Mexico on May 21, 1771, but lack of food supplies at Monterey and San Diego delayed the founding of Mission San Luis Obispo. Indeed, while awaiting ships and supplies from Mexico, Captain Pedro Fages with some of his men returned to the Valley of the Bears on a hunting trip and sent back to Monterey and Mission San Antonio 9,000 pounds of bear meat.

Mission Meccas

California's famous old missions with their historical and romantic background annually attract thousands of visitors. Twenty-one Franciscan missions were founded by the Reverend Fray Junipero Serra and his colleagues, extending from San Diego to Sonoma. On his way north from San Diego, Father Serra and the mission padres who came after him followed a course which became known as El Camino Real, "The King's Highway." El Camino Real retains to this day its original name and is designated U. S. 101. Along this highway and short distances from it, the founding padres established their missions. U. S. 101, the old "King's Highway," now extends from the Mexican border into northern Washington.

Present day State highways lead to all the mission sites. When the war is ended and California again welcomes tourists from all over the world and there are no longer restrictions on automobile travel, it is believed that the missions will be popular meccas for visitors to the Golden State.

Anticipating this traffic, the Division of Highways will publish in California Highways and Public Works brief histories of the missions with directions on how to reach them over State highways. For the purpose of this series, the missions will be taken up in the order of their locations from south to north, rather than in the sequence of their founding.

This is the sixth of the series.

The ships with food reached San Diego in August, 1772, and landed with their cargoes there for transportation north. So Fr. Serra set out for San Diego with Fages, determined to

found Mission San Luis Obispo on his way south.

Those familiar with the thriving city of San Luis Obispo of today, where is situated the mission of that name, may be interested in the description of the site as recorded by Fr. Francisco Palou, biographer of Fr. Serra. Speaking of the expedition of Fages and the establishment of the mission, Fr. Palou wrote:

"Thus in time the company arrived in the vicinity of Bear Valley. After surveying the locality, it was determined to found the mission about half a league before reaching the Canada de los Osos, yet in sight of it, on a level plot, which to all appeared most suitable for the mission on account of two little arroyos which contained water with sufficient lands that with but little trouble could be irrigated from them. For the site of the mission a slight elevation below which ran the two arroyos was designated. The Cross was constructed and immediately an arbor (enramada) was erected for the chapel. After the blessing and the sacred ceremonies * * * the standard of our Redemption was planted and venerated. On September first of said year 1772, the Rev. Father Presidente Serra celebrated the first holy mass on an altar, which had been prepared in the arbor, and thus the beginning was made of the Mission dedicated in honor of San Luis Obispo de Tolosa."

PADRES HARDY SOULS

The padres of those early mission days were enured to privations but it would seem that Fr. Jose Cavaller, left at San Luis Obispo by Fr. Serra when he resumed his journey to San Diego, must have been endowed with superhuman ability to sustain himself and his assistants on scant rations for Fr. Palou records that:

"As a guard for said mission, Captain Fages left two leather-jacket soldiers and three Catalonian Volunteers. In addition, the Fr. Presidente assigned two Lower California neophytes in order that they might begin to build the dwelling and chapel. For the maintenance of the missionary



This is Mission San Luis Obispo de Tolosa as it looks today

Father, the five soldiers and the two Indians, the captain left there 50 pounds of flour, three pecks of wheat for sowing, a quantity of chocolate, and a box of brown sugar for which latter they might obtain wild seed from the gentiles (Indians)."

Just what Fr. Cavaller would have done had the natives proved hostile is problematical, but it so happened that the Indians were grateful to Captain Fages and his soldiers for having slain so many savage bears that frequently attacked and killed them and they came in numbers to the embryo mission bringing venison and wild seeds which furnished sustenance for the little band.

FATHER SERRA PLEASED

The first year was a hard one for Fr. Cavaller. Three times the mission suffered from fire, the first blaze being started by a disgruntled Indian who fired a blazing arrow into the grass roof of the mission building. The origin of the other two fires was not known. However, they proved of benefit because the mission fathers con-

trived to find a way to make tiles with which they roofed their structures and all other missions did likewise.

Fr. Serra stopped at San Luis Obispo in May, 1774, on his way from Mexico to Monterey and expressed himself delighted with the progress made. He, himself, baptized six Indians. By the end of 1774 about 107 Indians had been baptized and 28 marriages blessed.

On March 1, 1776, Lieutenant Colonel Juan Bautista Anza and his expedition stopped at the mission on their second trip from Sonora, Mexico, to San Francisco and Fr. Pedro Font of Mission San Joseph de Los Pimas, Sonora, left behind him an interesting and accurate account of Anza's journey and the visit to San Luis Obispo.

"The Indians of this mission," Fr. Font wrote on his visit to San Luis Obispo, "are clean, tidy and better looking and handsomer than those of any other tribes so far as I have seen."

FAREWELL TO FATHER SERRA

Fr. Serra visited San Luis Obispo again on November 28, 1778, and

confirmed 53 neophytes. Again in March 1782, the Fr. Presidente of the Missions appeared at the mission and confirmed 79 neophytes. He was en route south and in May on his way back to Monterey he paid another visit. On November 29, 1783, he came to say farewell to the padres realizing that his advancing years would make any future journey to his beloved stations impossible.

Though Mission San Luis Obispo was one of the smallest of the missions, it nevertheless contributed its share of an assessment levied against the California Franciscans in 1782 by the King of Spain to help him carry on his war against England. It sent \$107 to Spain.

From 1794 to 1809 building operations at San Luis Obispo were quite extensive. In 1804 the mission had its greatest number of neophytes, 832, and by the end of that year the records showed a total of 2,074 baptisms and 1,091 deaths. In May, 1807, the mission was designated as one of six missions in which the California padres

could make their annual retreats for spiritual exercises.

Beginning in 1811 and continuing through 1820, the missionary fathers caused to be erected numerous dwellings for their Indians, made many improvements and additions to the mission and in 1819 finished constructing the quadrangle of the mission. A year later the two mission bells arrived from Lima Peru.

MILITARY DEMANDS

Following Mexico's revolt against Spain in 1810, Mission San Luis Obispo was compelled, as were all the California missions, to contribute food and clothing to the army, which the government ceased to support. Fr. Luis Martinez at San Luis Obispo many times found himself and his Indian wards suffering privations because of the constant demands of the military.

Fr. Martinez was a jovial soul and his wit and good humor won him widespread fame in those early days. His sarcastic comments on the idleness of the soldiers got him into trouble with Governor Sola in 1816, but two years later he won the good graces of the army when he valiantly led a company of his Indians to Santa Barbara and San Juan Capistrano, many leagues distant, to help defend the missions against two shiploads of South American privateers who had landed at Monterey and engaged in looting and then sailed south to Santa Barbara and San Juan Capistrano. Governor Sola so far forgot his animosity toward Fr. Martinez as to recommend him highly to Viceroy Venadito. Fr. Martinez even contributed clothing to ragged soldiers without a demand being made upon him.

It seems a pity that he could not have finished out his missionary days under the happy circumstances that surrounded him at this time, the year 1822. But tragedy for Fr. Martinez lay just ahead.

TRAGEDY OF FR. MARTINEZ

Repeated offenses by soldiers at the mission forced Fr. Martinez to complain bitterly to the Governor. Finally, in January, 1825, abuses heaped upon the padre by insolent soldiers caused Fr. Martinez to close the doors of the church to them and later to apply for a passport to leave the country. One Vicente Cane falsely reported to Governor Jose de Echeandia, enemy of the missions, that Fr. Martinez, contemplating flight, had



Ancient doorway of Mission San Luis Obispo

shipped \$6,000 of mission money to Mexico. The story, as old records show, had no foundation of fact, yet it was the beginning of the end for Fr. Martinez.

Soldiers at the presidio of Monterey revolted in November, 1829, imprisoned their officers and then, with Joaquin Solis, their leader, marched on Santa Barbara, where they were repulsed. Echeandia seized upon this incident to accuse Fr. Martinez of having aided Solis and on February 3, 1830, ordered the arrest of the padre on charges of treason.

Fr. Martinez was forcibly seized at San Luis Obispo and taken to the Mission Santa Barbara where he was

held incommunicado. A farcical trial was held, perjured testimony taken and Fr. Martinez was ordered banished by Echeandia. The grief stricken friar sailed for Peru on March 20, 1830, at the age of sixty-four and after having served thirty-four years at the mission. Fr. Jose Joaquin Jimeno was sent from Mission San Luis Rey to San Luis Obispo.

MISSION IMPOVERISHED

Illness was decimating the ranks of the Indians at San Luis Obispo at an alarming rate and the military and civil authorities and settlers were rapidly ruining the mission by impoverishing it. Conditions at San Luis Obispo

were more deplorable than at any other mission at this time. Designing politicians furnished the Indians with liquor and disorders were frequent.

In October, 1835, Manuel Jimeno Casarin was named civil commissioner to take over the mission and its property. An inventory placed the value of the mission and its possessions at \$70,769. Fr. Ramon Abella remained on in the hope he could do something for his Indians. In February, 1840, he sadly reported that he did not even have candles for his church.

Eugene Dufлот de Mofras, noted French writer, visited San Luis Obispo in 1841 and wrote among other things: "In the Mission building, which is now in ruin, we found reduced to a state of greatest want, the oldest Spanish Franciscan of California, the Rev. Fr. Ramon Abella. The Mission has suffered such devastations that the poor friar was bedded on an ox-hide, and used the horn of an ox as a drinking cup, and for nourishment had only strips of meat dried in the sun."

The story of the ruin of San Luis Obispo under successive Mexican governors is similar to that of the other missions in California, as related in preceding chapters. On December 4, 1845, Governor Pio Pico sold Mission San Luis Obispo to Scott, Wilson and McKinley for \$500.

AMERICAN OCCUPATION

Then came American occupation of California. On September 2, 1859, President James Buchanan returned Mission San Luis Obispo and its lands to the Catholic church.

In 1857, Don Dolores Herrera, a Spanish American, whose eldest daughter had been educated at St. Vincent's College, Santa Barbara, and who was teaching school in San Luis Obispo, deeded to Right Rev. Thaddeus Amat, Bishop of Monterey and Los Angeles, a block of land in the rear of the old Mission to be used for the erection of a convent school. Herrera desired that his five other daughters be educated there.

Finally, in 1876, the convent was completed and eight sisters of the Immaculate Heart of Mary arrived there to take charge. The school was opened August 16, 1876. A new parochial and grammar school was added to the convent in 1926. A fire razed the convent in 1930. The new school was named "The Mission High" in honor of the old padres.

Mission San Luis Obispo has been restored and its priceless ancient paintings and relics are treasures worth seeing.

Visitors to Mission San Luis Obispo, in the city of that name, if coming from the south, follow the Coast Highway, U. S. 101, direct to San Luis Obispo. If a stop has been made at Mission La Purisima Concepcion, the route is from Lompoc north over State Route 56 to its junction with the Coast Highway just south of Orcutt, thence through Los Alamos, Santa Maria, Nopomo and Arroyo Grande to San Luis Obispo.

Coming from the north, mission visitors will motor direct from San Francisco over the Coast Highway to San Luis Obispo or they may come down the San Joaquin Valley, U. S. 99, turn west at Famoso on State Route 33 to Paso Robles and then south to San Luis Obispo.

San Antonio de Padua July 14, 1771

LONELY outpost of the Franciscan stations established by Fr. Junipero Serra, Mission San Antonio de Padua was founded far off what later became El Camino Real, "The King's Highway," by the Presidente of the California Missions on July 14, 1771. It was the third of Junipero's missions, now twelfth on the Trail of the Padres.

Situated in a pleasant oak-covered valley in the Santa Lucia Mountains, the site chosen by Fr. Serra was a spot where Gaspar de Portola and his expeditionary force had camped in September, 1769, on their way from San Diego in search of Monterey Bay.

In those first years of his missionary undertakings, the zeal of Fr. Serra knew no bounds, so that, having founded Mission San Carlos Borromeo at what now is Carmel, he set out from Monterey with a squad of soldiers, some lower California neophytes and Fathers Miguel Pieras and Buena-ventura Sitjar to locate a suitable place for his third mission.

BELLS RING OUT

Fr. Zephyrin Engelhardt, mission historian, relates that Junipero and his little party stopped close by a river which Fr. Serra promptly named San Antonio and had his goods unpacked. The bells brought along were suspended from a live oak tree. The sight

of them, says Fr. Engelhardt, aroused Fr. Serra's enthusiasm and he ran up to them, grasped the cords and rang them in a lively manner. Then he shouted:

"Hear, Oh Gentiles! Come! Oh come to the holy Church of God! Come, Oh come, and receive the Faith of Christ!"

In amazement, Fr. Pieras cried out: "Why, Father, do you tire yourself? This is not the spot on which the church is to stand, nor is there within hearing a single pagan soul. It is useless to ring the bells."

To which Fr. Serra replied: "O Father Miguel, let me give vent to my heart's desires; for I would that these bells were heard all over the world, or at least by all pagan people who live in this sierra."

The venerable padre's wish was fulfilled, at least in part, for a lone Indian, attracted by the sound of the bells, cautiously approached while Fr. Serra and his colleagues, having constructed, raised and blessed a large cross, were celebrating holy mass within a brushwood shelter wherein an altar had been placed. This on July 14, 1770, in honor of San Antonio, patron of the new mission, on the day dedicated to the seraphic Doctor, St. Buenaventura.

Observing the hesitant savage, Fr. Serra was filled with joy and in his sermon said: "I trust in God and in the favor of San Antonio that this mission will become a great settlement of many Christians, because we see here what has not been observed in any of the other missions founded hitherto, that at the first holy Mass the first fruit from paganism has been present. He will surely not fail to communicate to his tribesmen what he has seen."

INDIANS BEAR GIFTS

And, indeed, the lone Indian did not fail. Presented with colored glass beads, he hastened to his concealed fellows and soon many Indians came with gifts of wild seeds and acorns. They accepted the missionaries with great faith and confidence, so that 15 days later Fr. Serra set forth highly pleased for Monterey, leaving Fathers Sitjar and Pieras to build with the aid of the soldiers and the friendly natives the Mission San Antonio de Padua.

At the sacrifice of space which could be devoted to details of the demoralization of Mission San Antonio under Mexican rule decades later, but which details would be a repetition of the



Mission San Antonio de Padua in the early days of its decay

mission stories preceding this one, it may be worth while here to relate a strange tale recounted by Fr. Palou, biographer of Fr. Serra. Fr. Palou wrote in 1773:

"Among the Indians baptised at San Antonio was a woman whom they named Agueda, so old, that to all appearance she must have been 100 years of age. She came to the Fathers and asked for baptism.

"When they questioned her why she wanted to be a Christian, she replied that when she was very young, she heard her parents tell of the coming to that country of a man who was vested in the same habit that the missionaries wore. This man had not entered the land on foot but came flying; and that he told them the same that the missionaries were now preaching; and that remembering this she was moved to become a Christian. Not putting any credit in what the old woman related, the Fathers sought information on the subject from the neophytes. They all unanimously replied that thus they had heard it said from their ancestors, and that this tradition was general and handed down from parents to children.

STRANGE TALE

"When I heard this story from the Fathers," continues Fr. Palou, "I immediately remembered the letter which in the year 1631 the venerable Mother, Sister Mary of Jesus de Argreda, wrote to the missionaries engaged in the spiritual conquest of New

Mexico, in which letter, among other things, she told them that our Father St. Francis brought to these nations of the North two Religious of his order to preach the faith of Jesus Christ (which missionaries were not Spaniards) and that after affecting many conversions, they suffered martyrdom. After computing the time of their visits, I judged that perhaps it might have been one of these Religious of whom the neophyte Agueda spoke."

There is Fr. Palou's story and it would appear that with the Indians of San Antonio more than a century and a half ago there passed an interesting bit of California history that never can be checked.

"The fact," says Fr. Engelhardt, "that the Indians of San Antonio Mission district manifested such eagerness to learn more about Christianity, and their extraordinary willingness to help the missionaries in every way, lends a good deal of plausibility to the story of the woman and of her people."

SAN ANTONIO GROWS

Surrounded by friendly Indians, San Antonio grew apace and before his death Fr. Serra, in 1784, had the pleasure of counting 1,804 neophytes at this mission, realization of the hope he had expressed in his sermon on the day of its founding that there would be a large settlement of Christians there with the aid of God and San Antonio.

Four months after the founding of the mission, Captain Pedro Fages,

who did not approve of the missionaries, took away from San Antonio the military guard. Fr. Serra decided to go to Mexico and personally lay before Viceroy Antonio Maria Bucareli a protest against the growing opposition to his work on the part of Fages. The Viceroy sent word to California that military interference must cease.

The padres at San Antonio pushed building operations from the start. During the year 1776 the church was roofed with mortar and tiles and a street lined with adobe dwellings for the Indians was completed. Store-rooms, barracks, warehouses and shops were erected and irrigation ditches to carry water to the field from San Antonio River were dug. In 1779 a building 133 feet long for the church and sacristy was started and finished the following year. Old records reveal steady progress in building through the years. In 1813 the new church was completed and long before that a water power mill had been erected. The Indian community grew steadily. Wells were dug, a reservoir and aqueduct built. Heavy rains fell in San Antonio district in 1825, causing the collapse of a number of structures, but these were replaced by larger and stronger buildings.

With the arrival in 1825 of Governor Echeandia trouble began for San Antonio as it did with the other missions. While other missions were stagnating under political rule in 1827, Fathers Juan Bautista Sancho and Pedro Cabot continued building at San An-



All that remains of Mission San Antonio de Padua is shown in this recent photograph

tonio against heavy odds. The last official report from the mission was written by Father Cabot December 31, 1832.

TRUBLE BEGINS

Through successive Mexican administrations, San Antonio struggled along, burdened by excessive demands for food, clothing and money made and enforced by the military. The politicians made haste to seize the property of San Antonio and on November 12, 1834, Manuel Crespo arrived there as commissioner. Disorders followed, the Indians became addicted to liquor furnished by unscrupulous politicians and many scattered to their haunts in the mountains. Governor Figueroa finally was compelled to discharge Crespo and Jose M. Ramirez succeeded him.

In December 31, 1835, Fr. Mercado, reporting on conditions at the once happy and prosperous Mission San Antonio wrote: "So numerous are the Indians who wander about as fugitives or as vagabonds that one can not prudently make an estimate." Only a few years before, these natives had been happy and industrious under the regime of the padres.

Thousands of head of cattle, sheep and horses had disappeared and the

fields were uncultivated. In May, 1845, when Governor Pio Pico ordered the sale of the missions, San Antonio had been looted to such an extent that no one would bid for it. The following year came American occupation and Pico's expulsion. Mission San Antonio was restored to the Catholic Church by President Lincoln on May 31, 1862.

MISSION DESERTED

Reverend Doroteo Ambris, the last resident priest at Mission San Antonio, served there from February 29, 1846, to May 5, 1882. After his death, the mission was deserted and vandals and settlers gradually dismantled it, taking away the tiles on the roofs of the buildings and finally stealing timbers from the various structures. Patriotic citizens in San Francisco became incensed at this wanton destruction and in 1903, led by Joseph R. Knowland of Oakland, then State Senator and later Congressman, organized the California Historic Landmarks League. As president of the league and also head of the Native Sons of the Golden West, Knowland traveled throughout the State urging the raising of a Restoration Fund.

Reporting to the Grand Parlor of the Native Sons in 1903, the Historic Landmarks Committee wrote:

"Mission San Antonio de Padua, in Monterey county, is in a deplorable state of ruin. The roof of the once imposing chapel has fallen, and the walls of adobe, now unprotected, are year by year being leveled by the merciless elements. The beautiful arches are becoming ruined heaps, and the valuable tiles are disappearing. No Californian can view these picturesque ruins, covering several acres, and fail to become an enthusiastic advocate of mission restoration."

On June 19, 1904, the Historic Landmarks League held a meeting at San Antonio attended by church dignitaries and many persons interested in restoring the old mission. Fr. Zephyrin Engelhardt of Santa Barbara Mission was the celebrant of the holy Mass. He was the first Franciscan to celebrate holy Mass on the spot since the departure of the last resident Franciscan padre sixty years before.

With contributions raised by the Native Sons and Native Daughters restoration work was started, but had to be discontinued owing to lack of

(Continued on page 29)

Bridge Maintenance Practice On California Highway System

By M. A. EWING, Associate Bridge Engineer

THERE are 4,636 bridges on the California State Highway System omitting culverts. Of this number 3,142 are built of steel and concrete, 1,394 of timber or steel with timber approaches and 100 are steel bridges with timber deck systems. The estimated value of these bridges exclusive of State-owned toll bridges is \$12,500,000.

The protection of this investment and the maintenance of the bridges in such condition that they will best serve the traveling public is a duty of the Bridge Department of the Division of Highways. Within the Bridge Department, maintenance work is handled directly by the Maintenance and Research Section. Methods of repair and maintenance as developed and field tested by this section over a number of years have included several practices that are worthy of note and should be of interest to the engineers and construction men engaged in this work throughout the Country.

There will be no attempt made to enumerate all maintenance problems encountered, but the more important features of the work, with illustrations, will be covered in a series of articles, of which this is the fifth. It deals with Scour and Settlement Problems.

SCOUR of streambed, to greater depth than anticipated in design, presents difficult maintenance problems, and resulting damage varies from loss of supporting material to complete loss of the structure. The major failures are infrequent and each must be considered as a separate problem; methods of correction can not be generalized in a short article. Where the entire structure has been lost, it becomes a problem for the design and construction departments, however, structure settlement, resulting from stream scour, occurs almost every season and it is the problems connected with the correction or prevention of this condition that will be outlined in this article.

When designing repairs for a structure that has been damaged by scour, the first requirement, of course, is to restore it to a usable condition for traffic. The next question is whether additional safeguards against future scour are required, and, if so, to what extent. In most instances, the work necessary to restore the structure to a usable condition provides all the safeguards needed. Where additional protection is desirable because of a change in local conditions or deficiency in the original design, the extent of the work should be governed by the same factors of economy as would be applied to the bridge as a whole, such as the remaining service life, probable frequency of recurrence of the scour condition, etc.

These factors are difficult to evaluate in the limited time usually available but it is important to keep them in mind as there is a natural tendency toward overdesign of the protection

work when confronted with the emergency of a badly damaged structure.

GENERAL SCOUR ANTICIPATED

General scour, occurring over long distances of the streambed and continuing from year to year, is typical of mountain locations and does little damage to State Highway bridges. The condition is anticipated, the rate of scour estimated at the time of the original design, and the protection constructed accordingly.

An example of a troublesome condition occasionally encountered in mountain locations where the foundation material consists of boulders, is the loss of fines and small rock from between the boulders, leaving the footings supported at comparatively few points. The correction of this condition is difficult and expensive where there is water to fight, and satisfactory results are not easily obtained. Concrete is needed to fill the voids between the large boulders but the stream velocity is usually high and in the boulder and gravel formation the water can not be sealed off effectively.

Although the working area can not be dried up, the water can be stilled by means of a sacked concrete wall around the footing, and the voids in the foundation filled with concrete by pumping. The discharge pipe from the pump should be manipulated in somewhat the same manner as a tremie tube. The quality of the concrete so placed is questionable but if care is used, the strength will be adequate for ordinary footing pressures.

On one repair job an effort was made to work grout and small rock, together with sacked concrete, into the voids

under the footing while deflecting the current with sacked concrete. The grouting was not successful but most of the voids were filled with the rock and sacked concrete. Where the work can be done in the dry, formed concrete is most satisfactory. Heavy rock riprap is usually available for protection work in mountain locations.

FOOTING DEPTHS WATCHED

Streams in foothill locations and those on alluvial fans may be either scouring or filling and it is possible to have both conditions during the life of a bridge. It is here that footing depths may be inadequate and must be watched. Such a scouring stream is shown in **Picture No. 1** where the streambed lowered about six feet in one season. This stream joins a larger one about one mile below, and the recession was caused by scour in the main stream. It was necessary to reconstruct two of the bents but since the bridge is scheduled for replacement soon no protection work was done.

When the value of the structure is such that additional protection is required there are two general procedures to be considered. One is to restore the streambed to its original elevation by some means such as a check dam, and the other is to confine the protection work to the bridge itself, leaving the streambed free to fluctuate. Both methods were considered in the case of the bridge across South Branch of Big Tujunga Wash on Foothill Boulevard in Los Angeles County.

This is a modern continuous girder structure which was damaged by

Upper—Granite Canyon, Route 142, Kern County. Scour of 6 feet in one season. Center—South Branch of Big Tujunga Wash, Route 9, Los Angeles County. Sacked concrete riprap under construction. Lower—South Branch of Big Tujunga Wash, Route 9, Los Angeles County. Jacking the superstructure back to grade

stream scour in 1938. Two of the piers settled, once as much as nine inches, and the streambed lowered about six feet, leaving insufficient footing depth to withstand future scour.

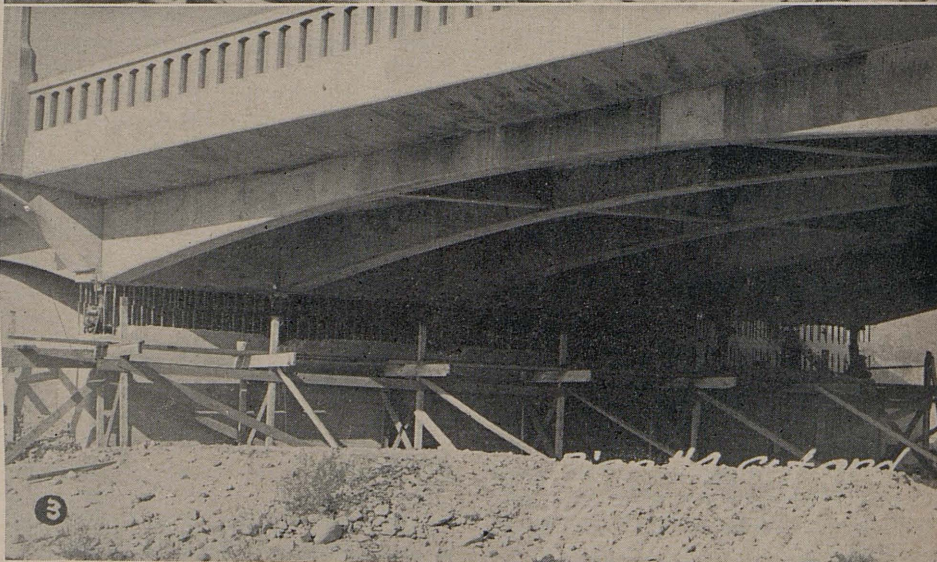
SACKED CONCRETE RIPRAP

A proposal for a check dam extending entirely across the channel at the downstream end of piers with a height sufficient to restore the streambed, was abandoned in favor of sacked concrete riprap extending six feet below footing at each pier. (Picture No. 2.) In constructing this type of protection, care should be used in excavating, in order to prevent loss of ground from under the footing and consequent settlement of the pier, and the time of construction should be chosen carefully as a flash flood would be disastrous. Obviously this type of repair can not be used in running water. In this case, sheet piles would provide a permanent repair if the type of soil and driving clearances permit. Otherwise, rock riprap will have to serve. At the end pier of this bridge it was necessary to cut the top of pier and jack the superstructure back to grade. This is shown in Picture No. 3.

Other examples of inadequate footing depth are common throughout the State, particularly among the older structures. Probably constructed during a filling phase of the stream, the footings have since been exposed by a scouring phase. As mentioned before, this condition is more common in foothill locations but may occur in the valleys as well. Cut-off walls of sacked or formed concrete constructed to a depth below any probable future scour provide a permanent repair. Formed concrete is necessary in many cases where load-bearing capacity is required, as well as protection for the remaining foundation material, but sacked concrete is preferred and is used whenever possible, as it can be extended if necessary and can be patched in case of damage.

KINGS RIVER BRIDGE

Picture No. 4 shows an abutment of the Kings River Bridge, VI-Kin-125-E, where it was necessary to con-



struct a small buttress fill as well as a sacked concrete cut-off. This is a valley location and was caused by a local shift of the stream. The founda-

tion material was considered capable of supporting the vertical loads and the buttress fill was intended to take the horizontal pressure from the base

Upper—North Fork of Kings River, Route 125, Kings County. Buttress fill riprapped with sacked concrete. Center—Poso Creek, Route 4, Kern County. Bent No. 4, damaged by scour and settlement, at start of repair operations. Lower—Poso Creek, Route 4, Kern County. General view showing damage from scour

of the abutment. Grout can be pumped into the area under the footing to stabilize the foundation material if necessary. This is usually done after the riprap or cut-off walls are completed.

The foundation material, under the center pier of the South Fork Eel River Bridge on the Redwood Highway, was consolidated with grout after a heavy rock blanket had been placed around the footing. This pier which supports two 120-foot steel deck girder spans, designed continuous over the support, had settled 1.2 feet and tipped almost a foot at the top. The footing was 31 feet by 15 feet in plan and the downstream portion was under-scoured to a depth of several feet.

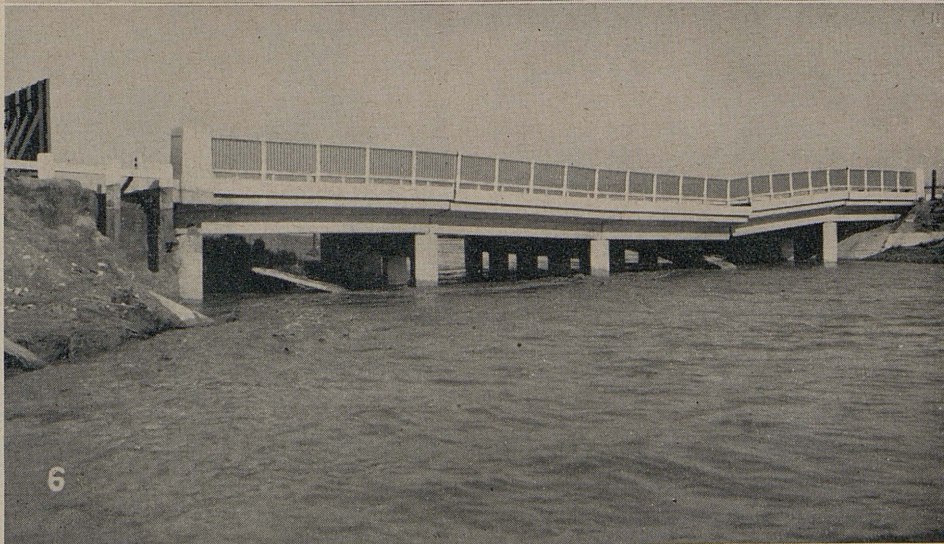
This was caused by a general lowering of the streambed during a period of abnormal high water. The pier shaft was hollow and holes were drilled and grout pumped through the footing from inside the pier. Twenty-three holes were drilled and 552 sacks of cement were used in this pressure grouting repair.

LOCAL SCOUR

The major portion of scour damage occurs under conditions that might be classed as local scour. Even a stream that is normally filling may scour to considerable depth because of a change in local conditions, such as the construction of a fence, growth of trees and brush, the accumulation of trash, or the reverse, such as cleaning the channel or the construction of control works nearby. There are many contributing factors and the majority are unpredictable. Such damage is pure maintenance and very little expense for additional protection can be justified.

The bent settlement at Poso Creek Bridge near Famoso, illustrates a repair where additional protection was not justified. This scour was caused by a combination of extreme high water, large square columns obstructing the channel, and cross currents which may have been caused by the lack of skew in the railroad bridge about 200 yards upstream.

The streambed is sand to considerable depth and scoured easily. Three



of the bents settled varying amounts, the maximum being more than five feet. The maximum differential settlement between the individual spread footings of one bent was about four feet. In designing the repairs it was considered that the original footing depth was adequate for the design flood, it was impractical to streamline the piers, and that no additional precautions should be taken to protect the structure from an exceptional flood such as that which caused the damage. Accordingly, two of the bents which had suffered no structural damage were reused; the deck being jacked back to grade and supported on concrete pads. The cap of the other bent was damaged because of differential settlement and the columns were out of plumb (Picture No. 5).

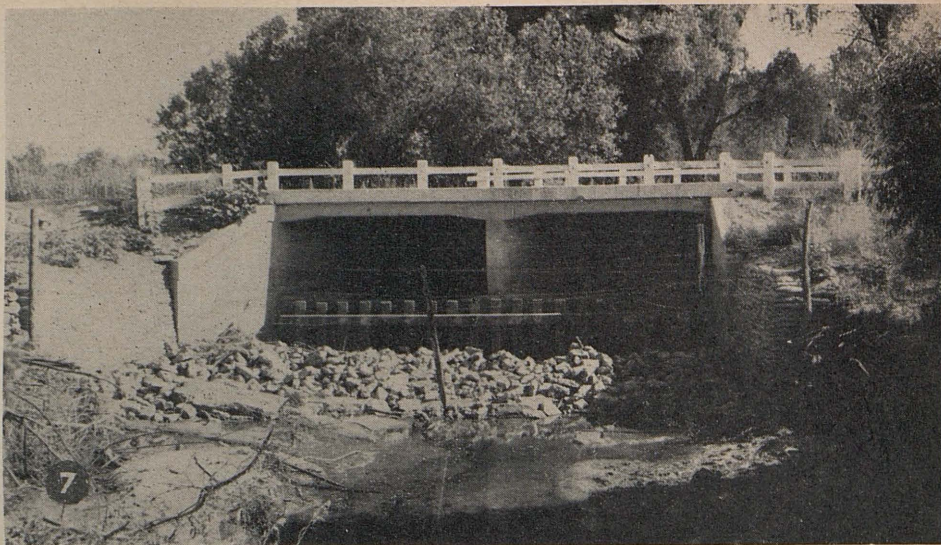
In plumbing the columns the footings were lowered somewhat, the two upstream columns being lowered as a unit, the other separately, and a new cap constructed. Final footing elevation for the two upstream columns was about six feet below original elevation. Five feet of this represented settlement, the other foot being gained in the plumbing operation. The original rigid concrete slope paving was damaged severely (Picture No. 6) and was replaced with sacked concrete riprap.

EXAMPLES OF SCOUR CONTROL

Examples of scour control and training works are shown in (Pictures No. 7 and No. 8), where the channel downstream from the bridges lowered as much as seven feet with scour holes nine feet deep. The timber cut-off wall (Picture No. 7) was placed under emergency conditions and is of temporary construction. The drop structure (Picture No. 8) is a permanent type and provides training walls for turning the stream. The invert slab of these structures acts as a check dam and the scour is controlled by rock riprap in one case and the concrete drop structure in the other. No other general correction procedure could be considered since the invert slabs are an integral part of the bridges. The scour is attributed to the "brushing out" of the channel downstream from the highway and to control works upstream. The normal bed load of the stream was removed at the control works and thus disturbed the balance between scouring and filling.

SAND PROBLEMS

The sand in sand channels is disturbed at considerable depth during



Depression Ditch, Route 10, Tulare County. Temporary timber cut-off wall

high water periods. Apparently, only a small portion of this sand is actually moved downstream and this is replaced as the stream recedes. At Goose Lake Slough in Kern County it was reported that soundings during the highwater of 1943 found bottom about 12 feet below normal streambed. Concrete columns with spread footings, used previously for pile replacement at this location, were lost. In repairing the flood damage a new pile bent was driven since the depth required to be safely below the turbulent sand was too great for spread footings.

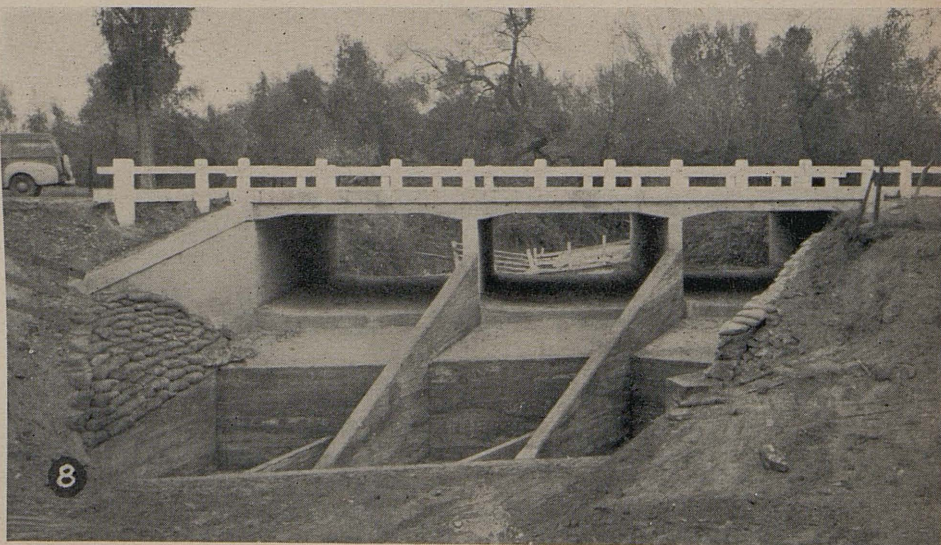
Much scour and settlement is caused by the obstruction of the pier itself. Even with normal flow the roller at the upstream end of a square ended pier will scour out a pothole a foot or

so deep if the streambed is at all unstable. The combination of square ended piers and the increased velocity of flood flows will damage the foundations even when quite deep.

The upstream end of a pier usually settles more than the downstream end, because of the additional scour caused by this roller. This twists and damages the superstructure of the bridge and complicates the repair work. The piers of major structures are usually streamlined but this has been neglected on small structures and culverts. A rounded or pointed nose on any pier will reduce the amount of differential settlement, if the pier should be undetermined, and can be provided at very little additional cost if included in the original design. Such protection has

(Continued on page 28)

Outside Creek, Route 10, Tulare County. Concrete drop structure



War Time Highway Construction in District V Aggregated \$9,500,000

By L. H. GIBSON, District Engineer

ESTABLISHMENT of four major army camps and one large training area prior to Pearl Harbor in the coastal counties of Monterey, San Luis Obispo and Santa Barbara, in District V, required that immediate steps be taken to provide adequate access roads for the anticipated abnormal traffic volumes and military needs.

Recognizing that adequate access roads were an essential part of the military establishments, commanding officers initiated a series of conferences starting in December, 1940, at which systems of access roads deemed necessary for each of the various establishments were designated. Expeditious approval of preliminary surveys and estimates by the Public Roads Administration permitted undertaking surveys shortly after the conferences. This made it possible for two projects to be undertaken by the Works Projects Administration early in 1941 prior to the time funds became available under the Defense Highway Act of 1941.

110 MILES OF ACCESS ROADS

Although a total of nearly 140 miles of surveys were made by this district during the entire access program, the final construction was reduced to 110 miles, of which 48 miles were on State highways and 62 miles on county roads. With surveys and plans on the original 140 miles of highways to be completed in as short a time as possible, the problem of obtaining sufficient experienced personnel became acute. Extensive military construction and expanding war industries and military services had practically exhausted the supply of engineers, making it necessary to borrow personnel from districts having less urgent work, employ and train inexperienced personnel on the job and to work the personnel overtime.

Construction of the 110 miles of access roads, all under the supervision of the Division of Highways, was completed between April, 1941, and June, 1944, at a cost of \$8,400,000 under 22 contracts, two day labor, and two

Work Projects Administration projects. The access road program varied in scope from grading and paving four-lane divided highways to widening and resurfacing existing highways which were distressed by the unusual heavy military traffic.

LARGE CONSTRUCTION PROGRAM

In addition to this large access road program, one major project deemed essential to national defense and 11 resurfacing projects have been constructed by this district since Pearl Harbor. These projects involved developing three miles of existing two-lane highway into a four-lane divided highway north of Salinas and repairing 91 miles of existing highways by reinforcing and resurfacing at a total cost of \$1,120,000.

This large construction program was completed in a comparatively short period in spite of the impediments induced by the expanding war industries and military construction which carried higher priorities than the highway construction.

Shortages of labor, materials and equipment and repair parts were major obstacles to be contended with and in some instances it was necessary to canvass labor from distant points and furnish daily transportation or living accommodations. Delays due to equipment breakdowns became a matter of days in place of hours. Preclusion of the use of some material by regulations promulgated subsequent to letting of contracts and depletion of the supply of others required modifications of contracts in many instances to provide for the use of best available substitutes. Congestion of railroad facilities and the shortage of railroad equipment added to the difficulty of obtaining materials.

VALUABLE IN PEACE TIME

Though the access roads were constructed primarily to serve pressing military needs, they will also be of value to public traffic, particularly on return of normal travel after termination of the current conflict. Improvement of the substandard secondary

highways by relocation and reconstruction between Seaside near Monterey, and the Coast Highway (U. S. 101) near Prunedale, provides a shorter and less congested route than that previously used through Salinas for traffic between the San Francisco metropolitan area and the popular Monterey Peninsula recreational area.

Replacement of the little improved original El Camino Real between Bradley and King City via Jolon with an all-weather modern highway provides easier access to the extensive Jolon farming area and lends to development of the rugged wilds of the Santa Lucia Range in the Los Padres National Forest for recreational purposes.

Need of a more direct route between the rich agricultural areas of Lompoc and the Santa Maria Valley, in Santa Barbara County, had been recognized for some time. A portion of the route between the Santa Ynez River and San Antonio Creek was constructed as a feeder road project in 1939, but funds had not as yet become available to complete the projected route. With the establishment of Camp Cooke, the section between the San Antonio Creek and Casmalia was built as a part of the camp construction to serve as an interior camp road and provide an outlet from the camp to the north. Replacement of the existing circuitous substandard county roads by construction of a modern highway as an access road between Casmalia and Santa Maria completed a modern highway which will materially facilitate movement of farm produce to market.

FORT ORD SERVED

In the access program on State Routes 56 and 22 in the vicinity of Fort Ord, in Monterey County, a total of 16.5 miles was graded and paved, approximately 6 miles of which is four-lane divided. This section also includes one railroad grade separation, two pedestrian crossings and two bridges.

The four-lane portion of this project, which is on the Monterey end, consists of 4.5 miles of armor coat on



Casmalia-Santa Maria Access Road. On the horizon at the right may be seen the big cut which is 100 ft. deep and contained 240,000 cu. yds. of excavation

crusher run base and 1.5 miles of Portland cement concrete pavement with curbed dividing strip. The two-lane portion, extending from Marina to U. S. 101, included 5.3 miles of Portland cement concrete pavement and 5.2 miles of plant-mixed surfacing on crusher run base. The construction period of these projects extended from March, 1942, to June, 1944.

There was a total of nine contracts covering this construction which were more fully discussed in the September-October, 1944, issue of California Highways and Public Works.

CAMP HUNTER LIGGETT

Establishment of Camp Hunter Liggett as a large mountainous training area for army personnel from various other camps necessitated construction of suitable access roads from U. S. 101 (State Highway Route 2). The route selected followed approximately along the original El Camino Real between Bradley and King City.

This project included grading and surfacing 40.4 miles and construction of two bridges. There was a total of four contracts and one WPA project involved in this section, the WPA constructing the nine-mile section through the military reservation. One bridge within the reservation was included in the WPA project while the other bridge across Pine Creek near King City, was included in the adjacent road contract. During the latter part of construction on the WPA project much of the work, including the base and surfacing, was turned over to one of the contractors on an adjacent section by the WPA. The WPA project started in May, 1941, and the last contract was completed in January, 1943.

In general, the roadway was 44 feet in width, which included a 22-foot plant-mixed surfacing 3 inches thick on cement treated base 6 inches in thickness, and 8-foot shoulders penetrated and sealed with a Class "C"

medium seal coat. The plant-mixed surfacing was sealed with a Class "C" fine seal coat.

UNUSUAL FEATURE

One unusual feature of the contract on the Bradley end of the project was the utilization of the existing bridge on State Route 2 over Hames Creek as an underpass for northbound traffic turning left or westerly toward Jolon. This was done to avoid a left turn by convoys which would have tied up through traffic on the main line highway. The separation of traffic was accomplished by carrying Hames Creek through a new concrete culvert, the top of which became the base for the roadbed section on the access road.

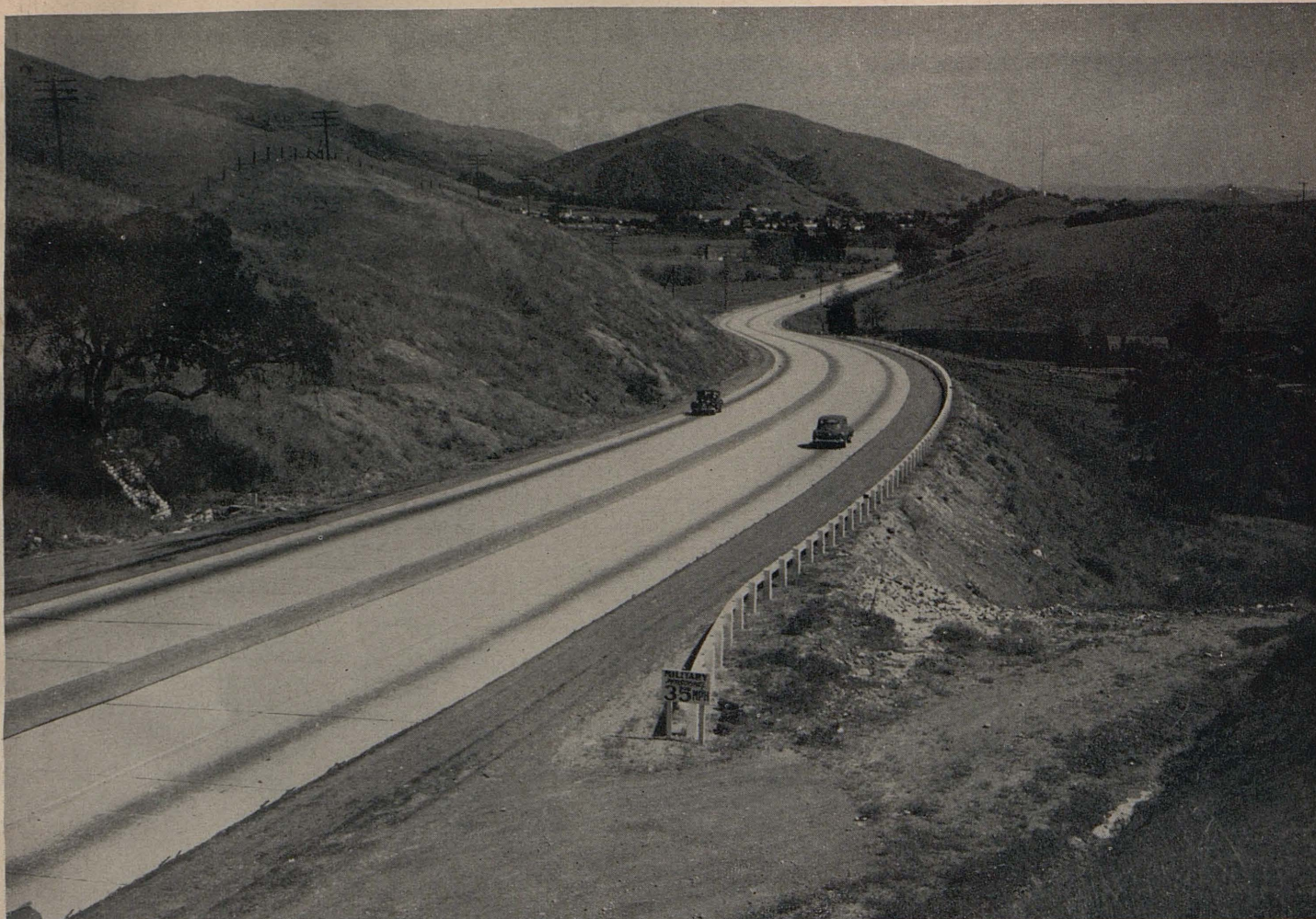
The major portion of the 6.5 miles access road on State Route 56 between San Luis Obispo and Camp San Luis Obispo was constructed by the WPA. As the entire project was not completed on February 13, 1943, the clos-



Looking southerly toward Fort Ord on Monterey-Castroville access project on State Route 56

Looking northerly from Jolon Summit on Access Road between King City and Camp Hunter Liggett





Four lane divided P. C. C. highway between San Luis Obispo and Camp San Luis Obispo. Access highway on State Route 56

ing date of WPA activities, a project financed with access funds was approved and constructed during the year. This contract included curbs and gutters, guard rail, guide posts, surfacing of shoulders and road approaches, downdrains and other miscellaneous items of work. As in the case of the Jolon WPA project, much of the work during the latter stages of this WPA project was let to contract by the WPA because of the lack of relief labor.

CAMP SAN LUIS OBISPO

From the city limits of San Luis Obispo to past the main gate of Camp San Luis Obispo the roadbed consists of 4.5 miles of four-lane divided Portland cement concrete pavement, the remaining portions being two-lane Portland cement concrete. The WPA project included construction of a 395-foot four-span bridge across Chorro Creek, California Boulevard, a main camp road, and the camp spur of the

Southern Pacific Railroad. Construction on this project ran from the beginning of WPA work in April, 1941, to the completion of the final contract in December, 1943.

In addition to the above access project between San Luis Obispo and Camp San Luis Obispo it was also necessary to relocate 7.9 miles of State Route 58 around the proposed Salinas River reservoir east of Santa Margarita which was to be constructed to provide an ample water supply for Camp San Luis Obispo. This highway relocation was designed by and constructed under the supervision of the Division of Highways although built under a negotiated contract let by the U. S. War Department. This highway relocation was constructed between August, 1941, and January, 1942.

CAMP COOKE

Access roads to Camp Cooke were constructed under three separate access projects, one project being from

the northerly reservation boundary near Casmalia to Santa Maria, the other two covering the section between the easterly boundary near Lompoc and Buellton, a portion of which is on State Route 149.

The Casmalia-Santa Maria section included one contract for 13 miles of grading and surfacing and one contract for two overhead crossings of the coast line of the Southern Pacific Railroad. Except through the sections where there was heavy grading the roadbed width is 38 feet, being reduced to 28 feet through these heavy sections. The project was set up as stage construction which provided an un-surfaced plant-mixed base 6 inches thick on imported borrow 6 inches and 12 inches in depth. The plant-mixed base was produced locally, the grading of the material being predominantly on the fine side. An asphalt having a penetration of from 85 to 100 was used as a binder and the base was placed in two courses using a self-

MONTEREY COUNTY

State Highway Rte. or County Road	Location	Type of Work	Contractor	Length in Miles	Cost	Access to
Rte. 56	Seaside Jct. to N. Reservation Bdry.	Grade and Surface	M. J. Ruddy & Son	4.70	\$146,649	Fort Ord
Rte. 56	N. Res. Bdry. to Marina	Grade and Pavement	Wilkinson & Scott	1.50	271,898	Fort Ord
Rte. 56	Marina to Castroville	Grade and Pavement	Granite Const. Co.	5.15	503,019	Fort Ord
Rte. 56	Tembladero Slough	Bridge	Dan Caputo	0.02	21,524	Fort Ord
Rte. 56	Fort Ord Pedestrian Crossings	Two Grade Separations	Dan Caputo	---	102,494	Fort Ord
Rte. 56	Salinas River at Neponset	Bridge	Oser & Sorenson	0.15	376,127	Fort Ord
Rte. 56	Salinas River at Neponset	Detour on R. R. Bridge	Day Labor	---	3,369	Fort Ord
Rte. 56	Salinas River at Neponset	Complete Approaches	J. B. Allen	---	14,271	Fort Ord
Rte. 22	Castroville to Rte. 2	Grade and Surface	Harms Bros.	5.19	465,542	Fort Ord
Rte. 22	Over S. P. R. R. near Castroville	Grade Separation	Kiss Crane Co.	0.04	45,363	Fort Ord
County	East Garrison to Rte. 117	Grade and Surface	Granite Const. Co.	4.70	108,107	Fort Ord
County	Hames Cr. to Hames Valley School	Grade and Surface	Louis Biasotti & Son	5.90	405,714	Camp Hunter Liggett
County	Hames Valley School to E. Res. Bdry.	Grade and Surface	N. M. Ball Sons	13.10	654,581	Camp Hunter Liggett
County	E. Res. Bdry. to N. Res. Bdry.	Grade, Surface and Bridge	WPA and two Subcontractors	9.04	623,037	Camp Hunter Liggett
County	N. Res. Bdry. to Quinado Canyon	Grade and Surface	Brown, Doko & Baun	3.86	285,828	Camp Hunter Liggett
County	Quinado Canyon to King City	Grade, Surface and Bridge	Basich Bros.	8.50	471,034	Camp Hunter Liggett
		Rights of Way on State Highways			122,489	
		Rights of Way on County Roads			39,190	
Total Monterey County				61.85	\$4,660,236	

SAN LUIS OBISPO COUNTY

State Highway Rte. or County Road	Location	Type of Work	Contractor	Length in Miles	Cost	Access to
Rte. 56	San Luis Obispo to Pennington Crk.	Grade, Pavement and Bridge	WPA and Four Subcontractors	6.45	\$1,642,595	Camp San Luis Obispo
Rte. 56	San Luis Obispo to Pennington Crk.	Complete WPA Project	M. W. Stanfield Co.	(6.45)	43,184	Camp San Luis Obispo
Rte. 58	Rinconada Cr. to Salinas River	Grade and Surface	Dixon, Inc.	7.90	371,404	Road closure for Camp San Luis Obispo Reservoir
		Rights of Way on State Highways			62,847	
Total San Luis Obispo County				14.35	\$2,120,030	

SANTA BARBARA COUNTY

State Highway Rte. or County Road	Location	Type of Work	Contractor	Length in Miles	Cost	Access to
Rte. 149	Surf to Lynden School	Grade and Surface	Brown, Doko & Baun	3.50	\$37,740	Camp Cooke
Rte. 2	Between Harrison and Los Alamos	Strengthen Bridge	Day Labor	---	1,900	Camp Cooke
Rte. 149	Buellton to Cebada Canyon	Grade and Surface	Griffith Co.	13.60	378,320	Camp Cooke
County	Cebada Canyon to Camp Cooke	Grade and Surface	Calowell Const. Co.	3.30	188,601	Camp Cooke
County	Casmalia to Santa Maria	Grade and Surface	Fredrickson & Watson Const. Co. & Fredrickson Bros.	12.99	756,603	Camp Cooke
County	Over S. P. R. R. at Casmalia and Schuman	2 Grade Separations	Kiss Crane Co.	0.10	136,490	Camp Cooke
City St.	Castillo St. to Leadbetter Rd. in City of Santa Barbara	Grade and Surface	Fredrickson & Watson Const. Co. & Fredrickson Bros.	0.60	51,799	Naval Base
		Rights of Way on State Highways			13,635	
		Rights of Way on County Roads			44,243	
Total Santa Barbara County				34.09	\$1,609,331	
Total State Highways				48.20	\$4,624,370	
Total County Roads				62.09	3,765,227	
Grand Total Access Projects				110.29	\$8,389,597	
12 widening, reinforcing and resurfacing contracts				93.90	1,120,244	
Total District V				204.19	\$9,509,841	

propelled spreading and finishing machine. These contracts were completed between November, 1942, and December, 1943.

BUELLTON PROJECT

The Camp Cooke-Buellton project was constructed between June, 1943, and February, 1944, under two contracts, one between the easterly reservation boundary and Route 149, the other being on Route 149 from this junction on to Buellton. The project between the camp boundary and Route

149 is on new location and eliminates a circuitous route through Lompoc with a saving of about four miles. This section is 3.3 miles in length and consists of a 22-foot by 3-inch plant-mixed surfacing on a gravel base varying in depth from 9 inches to 12 inches. The original contract provided for an asphaltic emulsion seal coat with a cover of fine screenings but due to the lateness of the season MC-5 liquid asphalt was used instead of the emulsion with very satisfactory results.

The project on Route 149 between the easterly end of the above described cutoff road and Buellton consisted of widening and resurfacing the existing pavement on portions and grading and constructing new base and surfacing on line changes. The contract was 13.6 miles in length, 2.2 miles of which was new location, the balance being the widened and resurfaced section. Construction on the widened section consisted of placing gravel base borders 4 feet wide by 6 inches to 12 inches thick on each side

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Bay Bridge Truck Lane Improvement Speeds Movement of Vital War Traffic

By H. C. SNEAD, Associate Engineer,
San Francisco-Oakland Bay Bridge

WARTIME transbay traffic over the San Francisco-Oakland Bay Bridge has assumed a pattern differing considerably from that prevailing in the prewar period. While government-imposed restrictions on gasoline and tire sales have resulted in a noticeable reduction in passenger car travel over the upper deck, increased demands on freight haulers and bus operators, together with the augmented movement of military vehicles, has resulted in a 146 per cent increase in lower-deck traffic. Bridge facilities, although taxed to the utmost at times, have stood the test of this abnormal increase in traffic reasonably well, with the exception of the east-bound lower-deck approach to the toll plaza. Here, rather severe congestion resulted during the several traffic peaks which occur in an average day's operations.

Although there are eight toll lanes in both east and west directions at the toll plaza, only two of these are equipped with scales. Lower-deck traffic must therefore be segregated into two groups if it is to be moved with a minimum of delay through the toll lanes. The commercial trucks which must be weighed for tariff purposes are dispatched into the two outside scale lanes, while the buses and military traffic, the latter toll free, are permitted to pass through any of the passenger car lanes.

As the full impact of war traffic began to be felt, segregation of the different classifications of eastbound lower-deck traffic became more and more difficult. The then existing two-lane roadway approach from the lower deck to the toll plaza was separated from the passenger car roadway by a curbed dividing strip for safety purposes. During certain times of the day, traffic peaks taxed the two-scale lanes available beyond capacity and long queues of waiting trucks formed back from the weighing devices well beyond the end of the dividing strip, as shown in Figure 1. Eastbound buses and military traffic were thus prevent-

ed from entering the toll plaza and passing through the passenger car lanes. As a consequence, delays in the movement of high priority traffic were experienced.

A study of this problem by bridge engineers indicated that a realignment of the south side of the toll plaza, to relieve the bottleneck formed by the toll plaza south curb and the dividing strip separating the lower- and upper-deck roadways, was first necessary. Coupled with this, the construction of a third lower-deck approach lane extending back approximately 1,000 feet from the toll lanes would provide adequate storage space for the maximum number of trucks waiting for the scales at any one time and, also, leave an open lane for the movement of the other

classifications of lower-deck traffic. Appropriate roadway striping and signing would then reserve the third or left-hand lane in the improved area for the use of buses and military traffic.

Based on this preliminary study and design, District IV of the Division of Highways prepared plans and undertook construction of this improvement. This work, which included a new concrete pavement lane and subbase, armored shoulder, plaza sidewalks and curbs, and the relocation of lighting standards, water piping, fence and shrubbery, was completed under contract at a cost of \$16,218.

Since the success of the improvement depended largely on the cooperation of the bridge patrons, the management went to considerable length to

Before Improvement—Two lane lower deck roadway on Bay Bridge blocked by waiting trucks





After Improvement—Army convoy negotiates open third lane unhampered by waiting trucks

inform them of the purpose of the improvement in advance of its opening. Publicity in the form of letters and sketches of the improved roadway were mailed to all the principal transit and trucking companies using the bridge facilities, as well as Army and Navy commands. Through their cooperation and that of their drivers, who prompted by patriotic and other meritorious motives have been our best policemen in this instance, the new roadway has been a marked success.

During the first week of operation a few drivers blocked the third or "through" lane. Since then, however, buses, military traffic and emergency equipment now move through this lane without any delay from waiting trucks.

In Memoriam

Chester Ross Davis

The Division of Highways is mourning the death of Chester Ross Davis who passed away on June 13, 1945, after an illness of about four months. He was 55 years old.

Born in Valley, Nebraska, November 26, 1889, and educated in the schools of that State, Mr. Davis enlisted in the Navy on his eighteenth birthday anniversary. After four years' service he was engaged in civilian industry until the United States entered World War I when he again entered the Navy. He was discharged at the end of the war with the rating of warrant officer.

Mr. Davis entered the service of the State on August 22, 1928, in the Bridge Department of the Division of Highways. In October, 1931, he was transferred to the design office of the San Francisco-Oakland Bay Bridge which had just been opened in San Francisco. He worked continuously on the design, construction, and operation of the Bay Bridge from this time until September, 1940, when he was appointed engineer in charge of Carquinez and Antioch Bridges which were purchased by the State at that time. Mr. Davis served in this capacity until his death.

HIGHWAYS OF CALIFORNIA

(Continued from page 8)

Bixby Creek Bridge, 18 miles south of Carmel, is the west's longest reinforced concrete arch—342 feet. In stately grandeur, it crosses one of the most precipitous gorges, a breath-taking 270 feet above the tide. Big Creek Arch is another unusual structure. It consists of two 177-foot 6-inch arches and two hinged half-arches, all of reinforced concrete. This bridge is unique for two floating end-spans which allow for settlement of unstable ground at the abutments.

Despite the hazards and difficulties of construction, the Division of Highways has provided an interesting and scenic road benched into the bluffs of the Monterey Coast with the blue Pacific breaking in white foamed surf below and stretching off to the western horizon.

SNOW REMOVAL IN THE SIERRA

One of the most important and heavily traveled transcontinental American highways is U. S. 40. In California, this route crosses the Sierra over the historic Donner Summit at elevation 7,135.

This pass is situated between Reno and Sacramento about nine miles west of Truckee and is the location of the heaviest snowfall in the United States. Because of the importance of the route to highway transportation, it has been the policy of the Division of Highways to keep this road and highways of similar importance open to traffic throughout the entire winter.

Records of annual snowfall at the Norden Station of the U. S. Weather Bureau near the summit show average falls varying from about 300 to 500 inches, with falls during some years considerably higher, as for instance, during the winter of 1879-80 the snowfall totaled 783 inches and during recent years, the winter of 1937-1938, a near record of 598 inches of snow fell. It was estimated that during that winter maintenance crews removed a total of over 100,000,000 cubic yards of snow from various routes in the State Highway System.

SNOW REMOVAL PROCEDURE

The procedure followed by snow removal crews follows a general pattern. As soon as a storm starts, the plows and blowers move out onto the highway.

The practice is to keep the equipment working throughout the storm and as long thereafter as is necessary to completely clear the highway. In addition to clearing the roads of the snowfall and drifts, at certain locations there is also the problem of combating snow slides which may be of very considerable proportions. In one instance during the 1937-1938 winter a large slide at Deer Park on the highway between Truckee and Tahoe City required continuous operations for 12 hours in order to open a section 300 feet in length.

COST OF SNOW REMOVAL

The volume and cost of snow removal on the State Highway System varies with the severity of the season and the grouping of storm periods. During the eight seasons from 1936 to 1944 annual snow removal costs have amounted to the following:

1936-37..\$605,000	1940-41..\$420,000
1937-38.. 492,000	1941-42.. 524,000
1938-39.. 382,000	1942-43.. 331,000
1939-40.. 323,000	1943-44.. 516,000

The number of miles cleared each season does not of necessity follow the pattern of costs as is evidenced by the following figures for the six years from 1938 to 1944:

1938-39..4,189 miles	1941-42..4,130 miles
1939-40..3,281 miles	1942-43..4,343 miles
1940-41..3,809 miles	1943-44..4,200 miles

To conduct snow removal operations throughout the State Highway System, the Division of Highways has 30 auger type plows, 155 blade and V-type plows, two wideners, and one roto-blade. For safer and more efficient operation the larger units are equipped with both receiving and sending radio equipment for communication with the headquarters at the maintenance stations.

During the winter and early spring months the life of maintenance crews assigned to snow removal is lived far from a bed of roses. No matter what time of day or night a storm may start, operations begin immediately and work is carried through without cessation. This means long hours of strain and work so that State roads may be opened to traffic as soon as possible.

NOTE.—This is the first of a series of articles on Highways of California by Mr. Gallagher.

Bridge Maintenance

(Continued from page 20)

been included in repair work where practical.

Normal maintenance procedure during times of high water usually includes only the removal of drift and trash which may hang up on bridge piers and cause scour. Bed scour can not usually be detected while the stream is in flood until there has been settlement of the bridge but even then much can be done to prevent further damage. For example, a quantity of riprap dumped into the channel at the upstream end of an undermined pier may prevent additional damage, and will at least reduce the amount of differential settlement.

Bank scour which may damage the bridge foundations can be detected at once and controlled to some extent if the proper measures are taken. Scouring eddies can be broken up with a few well placed boulders or sand bags. Railroads appear to have had considerable success in emergency scour control by using large irregular shaped stones. Highway maintenance forces are usually not equipped to handle stones of such size under emergency conditions. They could be so equipped at small cost and it is believed that considerable expense for such preventative maintenance is justified.

Federal Aid to Secondary Roads Given Attention

(Continued from page 9)

for the purpose of matching the Federal funds, there are no funds available for expenditure at this time from these two sources. The purpose of the Federal Act is to provide for postwar construction.

Many of the counties have taken advantage of funds provided for under Senate Bill No. 1083, Chapter 565 for the purpose of preparing plans and specifications for postwar construction upon county highways. Of the plans now in preparation under this act, about \$10,000,000 of proposed construction will fall upon the proposed Federal Aid Secondary System. In fact some of the counties have sufficient program on the system to absorb all of the three-year funds. The funds which will be available for county road construction under the Federal and State Acts will be \$25,550,916.

CALIFORNIA MISSIONS

(Continued from page 16)

money. A new fund was raised, but the earthquake of April 18, 1906, that wrought such destruction in San Francisco, Santa Rosa, Palo Alto and other cities, hit Mission San Antonio also, and did much damage. Discouraged, but still determined to save something of the ancient mission, the Native Sons again set about restoration work, applying themselves intermittently to the task and whenever funds were available up to 1911.

Today there is not much left of San Antonio. Its ruins, a tower in which still hangs the mission bell, are a tragic reminder of the historic past, of the romantic period of the Franciscan padres in California.

While Mission San Antonio is situated some 18 miles off El Camino Real, the Coast Highway, U. S. 101, southwest of King City, and about 24 miles off the same highway northwest of Bradley, it is easily reached by automobile from either of these points.

The mission visitor from the south, after leaving San Miguel and Mission San Miguel Arcangel, will follow the Coast Highway to Bradley and there turn left and proceed in a northwesterly direction to the town of Jolon and Mission San Antonio.

Coming from the north, the route is direct from San Francisco on the Coast Highway to King City, thence southwest to Jolon.

The Inland Route through the San Joaquin Valley offers two highways to the mission. Motorists coming from the north will turn west at Hanford and proceed over the Sierra to the Sea Highway through Lemoore



The old bell of Mission San Antonio still hangs in its tower

and Coalinga to San Lucas, thence north 9 miles to King City and from there take the road to Jolon. Motoring north over the Inland Route, the visitor may take the Cholame lateral out of Bakersfield, proceed to Paso

Robles and then go north through San Miguel to Bradley and thence northwest to Jolon.

Next—Mission San Miguel Arcangel and Mission Nuestra Senora de la Soledad.

War Time Highway Construction in District V Aggregated \$9,500,000

(Continued from page 25)

of the existing 15 feet by 4 inches asphaltic concrete pavement to provide a 23-foot wide base for the resurfacing. This base was covered with plant-mixed surfacing and a seal coat with screenings. On portions of the project where the existing pavement showed signs of distress it was covered with a gravel blanket 6 inches to 12 inches thick to provide additional

stability. On the line changes a gravel base 23 feet wide by 9 inches to 12 inches thick was surfaced with 3 inches of plant-mixed surfacing and a seal coat.

A complete description of some of the smaller access projects has not been included, however, the accompanying table provides a general outline of the work accomplished.

This large program was under the general supervision of District Construction Engineer B. W. Booker until September, 1942, and District Construction Engineer C. E. Waite from this date until its completion.

The table accompanying this article gives a list of the projects, type of project, contractor and costs.

Less Accidents on Arroyo Seco Parkway Than on Some Los Angeles City Streets

(Continued from page 3)



A not unusual traffic jam at Figueroa and Vernon streets in Los Angeles

the semaphore type. These vary in spacing from a minimum of 520 feet to a maximum of 1827 feet.

WILSHIRE BOULEVARD

From East City Limits of Beverly Hills to Vermont Avenue, 4.65 miles.

Wilshire Boulevard extends approximately east and west with a small angle about one mile east of Beverly Hills.

The pavement is asphaltic and from Beverly Hills to Ogden Drive, a distance of about three-fourths mile, is 80 feet wide between curbs, the balance being 70 feet wide between curbs.

There is a double painted centerline stripe throughout, and two single painted stripes on either side of the center stripe, each 10 feet apart.

Parallel parking in an eight-foot width is permitted throughout.

This marking provides six traffic lanes throughout. In the portion

which is 80 feet wide between curbs there is a width of 12 feet between the outer stripe and the parking lane, while in the portion with the 70-foot width between curbs there is only seven feet between the outer stripe and the parking lane.

The lighting on Wilshire is the best of all the streets used in this study and consists of cast iron standards erected along the curbs with two light units each. Thirty-one intersections are controlled by three-light automatic signals on this section of Wilshire Boulevard. These vary in spacing from a minimum of 317 feet, to a maximum of 1954 feet.

Accident data for this study were secured from accident reports in the files of the Traffic Bureau of the Department of Police of Los Angeles through the kindness of B. R. Caldwell, Deputy Chief, Director of the Traffic Bureau, and his able and helpful staff.

Accident data for that portion of the Arroyo Seco Parkway in the City of South Pasadena were secured from accident reports kindly made available by the Traffic Department of the City of South Pasadena.

Deserved Promotion

Friends of Major Wm. H. King, who before the war was employed on the San Francisco-Oakland Bay Bridge, have learned with pleasure that he has been promoted to Lieutenant Colonel in the 40th Infantry Division now in the Philippines.

Colonel King, husband of Mrs. Ida G. King, 141 Elm Avenue, San Bruno, California, as ordinance officer of the 40th Division, is responsible for the requisition, repair and maintenance of all weapons and all motor vehicles in the division.

Highway Bids and Contract Awards for June and July 1945

June 1945

ALAMEDA COUNTY—An access road from Maitland Drive to Earhart Road in the Auxiliary Naval Air Station, Oakland Airport, about 1.2 miles in length to be graded and surfaced with plant-mixed surfacing on crusher run base and imported base material. District IV. Lee J. Immel, Berkeley, \$154,777; N. M. Ball Sons, Berkeley, \$164,249. Contract awarded to Frederickson & Watson Construction Co., Oakland, \$147,179.

KERN COUNTY—Between Mojave and Cinco, portions only, a net length of about 6 miles to be repaired by reshaping shoulders, applying prime coat and placing P. M. S. over existing surfacing and portions of shoulders, placing imported borrow on shoulders and applying penetration treatment thereto. District IX, Route 23, Section B. W. I. "Bill" Perry, Bakersfield, \$45,290. Contract awarded to Oilfields Trucking Co., Bakersfield, \$42,090.

KERN COUNTY—Between 1.2 miles south of Famoso and 1.0 miles north of Famoso, about 2.2 miles, to be repaired with plant-mixed surfacing. District VI, Route 4, Section E. Contract awarded to Griffith Company, Los Angeles, \$30,481.

KERN COUNTY—Between 14.8 and 17.8 miles east of Maricopa, between State Highway Route 139 and Rosedale and between 2.8 and 3.8 miles north of State Highway Route 140, about 10.1 miles net length, to be repaired with plant-mixed surfacing. District VI, Routes 57, 58, 139, Sections C, L, A. Contract awarded to Griffith Co., Los Angeles, \$53,960.

MENDOCINO COUNTY—Between Longvale and Laytonville, portions only, about 2.9 miles in net length, imported base material to be furnished and placed and armor coat to be applied thereto. District I, Route 1, Sections G, H. W. C. Thompson, San Francisco, \$42,761; Close Building Supply, Hayward, \$43,510; Clements & Co., Hayward, \$46,393; W. C. Railing, Redwood City, \$47,460; N. M. Ball Sons, Berkeley, \$48,512; C. M. Syar, Vallejo, \$53,964. Contract awarded to A. R. McEwen, Sacramento, \$42,337.

MENDOCINO COUNTY—Between Northwestern Pacific Railroad Underpass and 1.1 miles south of Willits, about 2 miles in length, imported base material to be furnished and placed and armor coat to be applied thereto. District I, Route 1, Section E. Clements & Co., Hayward, \$24,444; Close Building Supply, Hayward, \$28,375; W. C. Thompson, San Francisco, \$28,880; W. C. Railing, Redwood City, \$29,928; C. M. Syar, Vallejo, \$36,155; Peter Sorensen, Redwood City, \$37,504; N. M. Ball Sons, Berkeley, \$50,565. Contract awarded to A. R. McEwen, Sacramento, \$23,193.

MENDOCINO COUNTY—Between Navarro River and Mendocino, portions only, a net distance of about 1.9 miles, imported base material to be furnished and placed and seal coat applied thereto. District I, Route 56, Section D. J. Henry Harris, Berkeley, \$30,589; C. M. Syar, Vallejo, \$30,702; A. J. Clausen, Berkeley, \$44,730. Contract awarded to W. C. Railing, Redwood City, \$26,341.

MERCED COUNTY—Between 1.7 miles east of San Luis Creek and Los Banos and

between 1.7 miles north of Romero School and Los Banos, portions only, about 13 miles in net length, to be repaired with untreated rock base and plant-mixed surfacing. District X, Routes 32 and 41, Sections B, AB. N. M. Ball Sons, Berkeley, \$190,392; W. C. Thompson, San Francisco, \$216,819; Lee J. Immel, Berkeley, \$217,476; J. E. Haddock, Ltd., Pasadena, \$232,724; E. B. Bishop, Orland, \$239,152. Contract awarded to Louis Biasotti & Son, Stockton, \$180,747.

MONTEREY, SAN LUIS OBISPO AND SANTA BARBARA COUNTIES—Painting maintenance station buildings at Big Sur, Willow Springs, San Lucas, Priest Valley, Cambria, Shandon, Santa Maria, Buckhorn, Cuyama, Buellton, and Santa Barbara. District V. Wm. R. Morgan & Co., Los Angeles, \$9,495. Contract awarded to Dan Sullivan, Santa Monica, \$7,890.

NAPA COUNTY—Veterans Home at Yountville, about 1.8 miles in length, existing bituminous surfaced roads within institution grounds to be scarified, recompacted and an armor coat applied, and unsurfaced existing roads to be surfaced with crusher run base and penetration treatment applied thereto. District IV. C. M. Syar, Vallejo, \$7,565; A. S. Jones, Napa, \$8,735; A. J. Clausen, Berkeley, \$9,180; K. R. C. Construction Co., Berkeley, \$9,641; J. Henry Harris, Berkeley, \$9,656; E. A. Forde, San Anselmo, \$10,117; J. C. Spalletta, Santa Rosa, \$12,670; Peter Sorensen, Redwood City, \$13,956. Contract awarded to Lee J. Immel, Berkeley, \$7,271.

NEVADA COUNTY—Portions between Truckee and Farad, about 3.4 miles in net length, to be repaired with plant-mixed surfacing, and crusher run base and plant-mixed surfacing to be stockpiled. District III, Route 38, Sections A, B. Isbell Construction Company, Reno, \$46,745. Contract awarded to Harms Bros., Sacramento, \$46,035.

RIVERSIDE AND SAN BERNARDINO COUNTIES—Between Riverside and Colton about 2.6 miles in net length, to be repaired by placing plant-mixed surfacing with seal coat over the existing surface, placing local borrow on portions of the shoulders and reshaping shoulders. District VIII, Route 43, Sections C, F. E. L. Yeager, Riverside, \$28,270; Griffith Co., Los Angeles, \$35,540. Contract awarded to Geo. Herz & Co., San Bernardino, \$27,950.

SACRAMENTO COUNTY—Between Isleton and Sacramento, portions only, about 8.5 miles in net length to be repaired with plant-mixed surfacing. District III, Route 11, Sections D, E, F. A. Teichert & Co., Sacramento, \$43,945; Asta Construction Co., Rio Vista, \$46,310; McGillivray Construction Co., Sacramento, \$49,404; Louis Biasotti & Son, Stockton, \$52,228. Contract awarded to Sheldon Oil Co., Suisun, \$41,733.

SACRAMENTO AND YOLO COUNTIES—Between North Sacramento and about 2 miles easterly and between one mile east of Davis and Swingle, about 4.8 miles in net length, to be repaired with plant-mixed surfacing on existing roadbed and on new crusher run base. District III, Routes 3 and 6, Sections B, A. McGillivray Construction Co., Sacramento, \$82,208; Louis Biasotti & Son, Stockton, \$87,365; J. R. Reeves, Sacramento,

\$93,792. Contract awarded to A. Teichert & Co., Sacramento, \$81,635.

SAN BERNARDINO COUNTY—Between Barstow and Field, about 22 miles in net length, to be repaired by placing plant-mixed surfacing over the existing surface and reshaping the shoulders. District VIII, Route 31, Sections G, H. The Tanner Construction Co., Phoenix, Arizona, \$179,330; Basich Bros. Construction Co., Alhambra, \$197,380; Lewis Construction Co., Los Angeles, \$197,472; Oswald Bros., Los Angeles, \$200,006; Match Bros., Colton, \$205,260; Griffith Co., Los Angeles, \$220,475; J. E. Haddock, Ltd., Pasadena, \$221,495; Dimmitt & Taylor, Los Angeles, \$259,510. Contract awarded to Schroeder & Co., Roscoe, \$173,775.

SAN BERNARDINO COUNTY—Between Daggett and Hector, about 7.25 miles in net length, to be repaired by placing plant-mixed surfacing over the existing surface and reshaping the shoulders. District VIII, Route 58, Sections F, G. Match Bros., Colton, \$50,000; Lewis Construction Co., Los Angeles, \$54,532; Oswald Bros., Los Angeles, \$63,255; Basich Bros. Construction Co., Alhambra, \$63,387; Geo. Herz & Co., San Bernardino, \$63,756; Griffith Co., Los Angeles, \$70,615; Dimmitt & Taylor, Los Angeles, \$81,352. Contract awarded to The Tanner Construction Co., Phoenix, \$49,175.

SAN JOAQUIN COUNTY—Between Stanislaus River and Manteca, about 7.1 miles to be repaired with plant-mixed surfacing. District X, Route 4, Section A. M. J. B. Construction Co., Stockton, \$50,220; Clements & Co., Hayward, \$50,372. Contract awarded to A. Teichert & Co., Sacramento, \$43,997.

SISKIYOU COUNTY—Between 4 miles north of Weed and Oregon State line, about 14.8 miles in net length, a Class "A-Medium" seal coat to be applied. District II, Route 72, Section A, Drs. C. Clifford A. Dunn, Klamath Falls, Oregon, \$19,829; Harms Bros., Sacramento, \$20,167. Contract awarded to W. C. Thompson, San Francisco, \$19,187.

SONOMA COUNTY—Between Bettane and Agua Caliente, portions only, about 3 miles in net length to be repaired by scarifying and reshaping existing surfacing and base, constructing crusher run base and placing plant-mixed surfacing. District IV, Route 51, Section B. N. M. Ball Sons, Berkeley, \$84,305; Lee J. Immel, Berkeley, \$85,629; C. M. Syar, Vallejo, \$86,358; A. G. Raisch Co., San Francisco, \$86,450; E. A. Forde, San Anselmo, \$87,702. Contract awarded to Louis Biasotti & Son, Stockton, \$81,585.

YUBA AND SUTTER COUNTIES—Between Morrison Crossing and Linda Corners, between Yuba City and Lomo, portions, and between Sutter Bypass and Tudor Road, about 12.2 miles in net length, to be repaired with plant-mixed surfacing on existing roadbed and borders to be constructed of imported borrow on portions of the project. District III, Routes 3, 87, Sections B, A, B. Marshall S. Hanrahan, Redwood City, \$124,877; Louis Biasotti & Son, Stockton, \$126,382; E. B. Bishop, Orland, \$147,180. Contract awarded to Lester L. Rice, Marysville, \$94,690.

VENTURA COUNTY—Between 0.6 mile northwesterly of Hueneme Road and Calleguas Creek, about 3.4 miles in length, to be

repaired with plant-mixed surfacing on untreated rock base. District VII, Route 60, Section A. R. R. Hensler, Glendale, \$119,930; Frontier Construction Company, Whittier, \$120,976; Norman I. Fadel, North Hollywood, \$121,180; Oswald Bros., Los Angeles, \$124,820. Contract awarded to Griffith Co., Los Angeles, \$114,735.

YOLO COUNTY—Between Madison and 2.5 miles south of Dunnigan, about 9.4 miles to be repaired with gravel base and penetration treatment. District III, Route 90, Section B. K. R. C. Construction Company, Berkeley, \$24,640; N. M. Ball Sons, Berkeley, \$26,308; A. J. Clausen, Berkeley, \$28,287; Harms Bros., Sacramento, \$29,000; F. E. Young, Berkeley, \$29,266; A. Teichert & Co., Sacramento, \$29,525; Clements & Co., Hayward, \$32,031; C. M. Syar, Vallejo, \$32,512; E. B. Bishop, Orland, \$36,375; Nevada Rock & Sand Co. Inc., Reno, \$39,497; Louis Biasotti & Son, Stockton, \$48,840. Contract awarded to R. A. Westbrook, Sacramento, \$23,890.

YOLO COUNTY—Between Davis Wye and Willow Slough, between Cache Creek and 3 miles north and between Woodland and 1.3 miles north, about 8.1 miles in net length, to be repaired with plant-mixed surfacing on existing roadbed and with plant-mixed surfacing on crusher run base and the shoulders to be constructed of imported borrow on portions of the project. District III, Routes 7, 87, Sections A, V, Wd. A. W. C. Thompson, San Francisco, \$118,770; A. Teichert & Co., Sacramento, \$125,649; Clements & Co., Hayward, \$131,617; Harms Bros., Sacramento, \$139,840; Louis Biasotti & Son, Stockton, \$152,784; E. B. Bishop, Orland, \$156,928. Contract awarded to N. M. Ball Sons, Berkeley, \$117,925.

July 1945

ALAMEDA COUNTY—Between San Joaquin County line and Livermore and between Niles and Sunol, about 6 miles to be repaired with plant-mixed surfacing. District IV, Routes 5, 107, Sections E, A. W. C. Railing, Redwood City, \$31,101. Contract awarded to Clements & Co., Hayward, \$27,797.50.

ALAMEDA COUNTY—Along Ward Creek, at Hayward, a reinforced concrete box culvert and trash box to be constructed. District IV, Route 105, Section Hayward, A. Clements & Co., Hayward, \$9,630; R. G. Clifford, South San Francisco, \$9,775; Dan Caputo, San Jose, \$9,891; A. Soda & Son, Oakland, \$12,910; Minton & Kubon, San Francisco, \$13,285; Peter Sorensen, Redwood City, \$15,281. Contract awarded to Wm. E. Thomas Construction Co., National City, \$8,906.

CONTRA COSTA COUNTY—Between Concord and Ohmer, about 2.5 miles to be surfaced with plant-mixed surfacing on existing pavement and on new crusher run base. District IV, Clements & Co., Hayward, \$29,837; Fredrickson & Watson Construction Co., Oakland, \$30,513; C. M. Syar, Vallejo, \$31,466; A. J. Raisch Paving Company, San Jose, \$39,176. Contract awarded to Lee J. Immel, Berkeley, \$29,422.

GLENN COUNTY—Between Oak Street in Willows and Orland, about 1.3 miles to be repaired with plant-mixed surfacing. District III, Route 7, Section Willows, B. C. N. M. Ball Sons, Berkeley, \$19,100. Contract awarded to E. B. Bishop, Orland, \$13,300.

INYO COUNTY—Between Fish Creek Road and Bishop, portions about 6.2 miles in

net length, to be repaired with imported borrow and plant-mixed surfacing. District IX, Route 23, Sections C, D. Vinnell Company, Alhambra, \$72,540. Contract awarded to Basich Brothers Construction Co., Alhambra, \$55,750.

INYO AND MONO COUNTIES—Between Alabama Gates and Whiskey Canyon, portions about 6.2 miles in net length, to be repaired by placing road-mixed surfacing over existing surfacing and reshaping existing shoulders. District IX, Route 23, Sections MB, AB. Basich Brothers Construction Co., Alhambra, \$19,192; R. R. Hensler, Glendale, \$20,540. Contract awarded to Vinnell Company, Alhambra, \$17,918.50.

KINGS AND TULARE COUNTIES—Between Hanford and State Highway Route 4, about 12.8 miles to be repaired with plant-mixed surfacing. District VI, Route 10, Sections A, A. Contract awarded to Brown, Doko and Baun, Pismo Beach, \$28,509.

LOS ANGELES COUNTY—In the city of El Segundo on El Segundo Boulevard, between Main Street and Sepulveda Boulevard, about 1.1 miles to be graded and surfaced with plant-mixed surfacing. District VII. Dimmitt & Taylor, Los Angeles, \$39,954; Oswald Bros., Los Angeles, \$40,448; Griffith Co., Los Angeles, \$41,749; Charles J. Dorfman, Los Angeles, \$42,031; J. E. Haddock, Ltd., Pasadena, \$43,076; Warren Southwest, Inc., Los Angeles, \$43,706; Chas. T. Brown Co., San Fernando, \$44,031. Contract awarded to Vido Kovacevich Co., South Gate, \$39,680.

MAREN COUNTY—Between San Rafael and San Quentin Wye, about 0.5 mile, an outer highway to be graded and surfaced with crusher run base and seal coat to be applied. District IV, Route 1, Section San Rafael, C. W. C. Railing, Redwood City, \$11,071; A. G. Raisch Co., San Francisco, \$11,275; J. Henry Harris, Berkeley, \$11,703; Peter Sorensen, Redwood City, \$12,392; C. M. Syar, Vallejo, \$12,585. Contract awarded to E. A. Forde, San Anselmo, \$10,116.

MENDOCINO COUNTY—About 8 miles north of Cloverdale, the existing bridge across Squaw Rock Slide to be repaired. District I, Route 1, Section L. Reed & Tuttle, Redwood Valley, \$9,940; James H. McFarland, San Francisco, \$10,217; Kiss Crane Co., San Pablo, \$11,585; John C. Spaletta, Santa Rosa, \$13,065; Mercer-Fraser Co., Eureka, \$14,650. Contract awarded to C. C. Gildersleeve, Wilcox, \$8,740.

MENDOCINO COUNTY—At Chadburn Creek, about 13.4 miles north of Fort Bragg, about 0.17 mile to be graded, surfaced with imported base material and a seal coat applied thereto. District I, Route 56, Section F. C. M. Syar, Vallejo, \$27,557; J. Henry Harris, Berkeley, \$29,624; W. C. Railing, Redwood City, \$31,964. Contract awarded to John Burman & Sons, Eureka, \$19,083.

MONTEREY COUNTY—Between San Ardo and King City, portions, about 8.7 miles in length, to be repaired by placing plant-mixed surfacing over the existing surfacing, reshaping existing shoulders and applying bituminous surface treatment thereto, applying seal coat to the plant-mixed surfacing and a liquid asphalt seal with sand cover to the shoulders. District V, Route 2, Sections G, F. Granite Construction Co., Watsonville, \$106,954; Brown, Doko Baun, Pismo Beach, \$113,278. Contract awarded to A. Teichert & Co., Sacramento, \$99,869.

NAPA AND SONOMA COUNTIES—Between Napa and Oakville and between Santa

Rosa and Beltane, about 7.5 miles to be repaired with plant-mixed surfacing. District IV, Routes 49, 51, Sections B, A. J. Henry Harris, Berkeley, \$44,424; E. A. Forde, San Anselmo, \$43,560. Contract awarded to A. A. Tieslau & Son, Berkeley, \$42,658.

PLACER-NEVADA COUNTIES—Between Gold Run and Kingvale, portions only, about 7.8 miles to be repaired with plant-mixed surfacing on existing roadbed and on new crusher run base. District III, Route 37, Sections DEF, A. R. A. Westbrook, Sacramento, \$49,302; Harms Bros., Sacramento, \$62,430. Contract awarded to Clements & Co., Hayward, \$48,926.25.

SANTA CLARA COUNTY—Between Gilroy and 4 miles southerly, portions only, about 2.4 miles to be repaired by surfacing with plant-mixed surfacing. District IV, Route 2, Section C. A. J. Raisch Paving Company, San Jose, \$28,767; H. Sykes, Patterson, \$33,146. Contract awarded to Granite Construction Co., Watsonville, \$26,088.50.

SANTA CLARA COUNTY—Between Alameda County Line and Milpitas, between Los Gatos and San Jose, between Saratoga and Los Gatos, and between Sunnyvale and Saratoga, a net total length of about 11 miles, to be repaired with plant-mixed surfacing. District IV, Routes 5, 42, 114, Sections AB, A. A. Contract awarded to A. J. Raisch Paving Co., San Jose, \$57,531.

SAN LUIS OBISPO COUNTY—Between Del Rio Avenue and Templeton, between Paso Robles and Monterey County Line, and between Estrella River and Cottonwood Pass Road, portions only, about 17.4 miles in net length, to be repaired by placing plant-mixed surfacing with an emulsion seal on Route 33 and applying a seal coat to existing surfacing on Route 2, District V, Routes 2, 33, Sections BA, BC. Contract awarded to Granite Construction Co., Watsonville, \$39,970.

SHASTA COUNTY—Between Bass Hill & Crespo's, portions only about 14 miles in net length, to be repaired by applying seal coat to the existing surfacing. District II, Route 3, Sections B, C. E. B. Bishop, Orland, \$17,300; A. A. Tieslau & Son, Berkeley, \$17,680. Contract awarded to J. Henry Harris, Berkeley, \$15,789.15.

TEHAMA COUNTY—Between Route 3 and 3 miles east of Paynes Creek, about 23.6 miles to be repaired with seal coat. District II, Route 29, Sections A, B. Clements & Co., Hayward, \$21,175; Marshall S. Hanrahan, Redwood City, \$21,810; Howard B. Folsom, Berkeley, \$23,442; W. C. Railing, Redwood City, \$24,405; A. A. Tieslau & Son, Berkeley, \$24,407; E. B. Bishop, Orland, \$24,775. Contract awarded to J. Henry Harris, Berkeley, \$20,590.50.

YOLO COUNTY—Between 0.5 mile south of Arcade Station and 2.25 miles north of Arcade Station and between the Yolo Causeway and 1 mile west of Washington Underpass, about 5.3 miles in length to be repaired with plant-mixed surfacing. District III, Routes 99, 6, Sections B, C. McGillivray Construction Co., Sacramento, \$34,420. Contract awarded to A. Teichert & Co., Sacramento, \$32,915.

YOLO AND COLUSA COUNTIES—Between Bretona and Genervra (portions) about 1.7 miles to be repaired with plant-mixed surfacing. District III, Route 7, Sections C, A. E. B. Bishop, Orland, \$11,500. Contract awarded to N. M. Ball Sons, Berkeley, \$11,130.

State of California
EARL WARREN, Governor

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A. H. HENDERSON, Assistant Director

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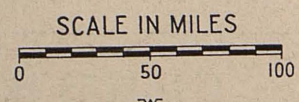
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C. C. CARLETON, Chief
FRANK B. DURKEE, Attorney
C. R. MONTGOMERY, Attorney

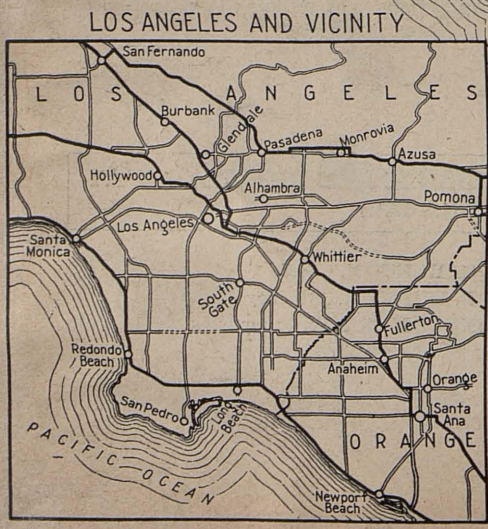
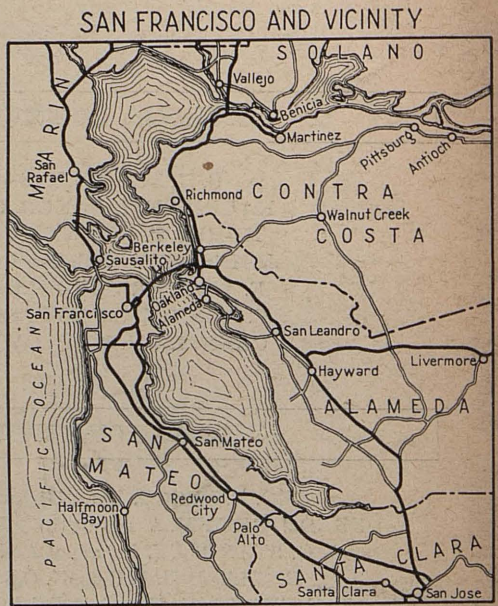
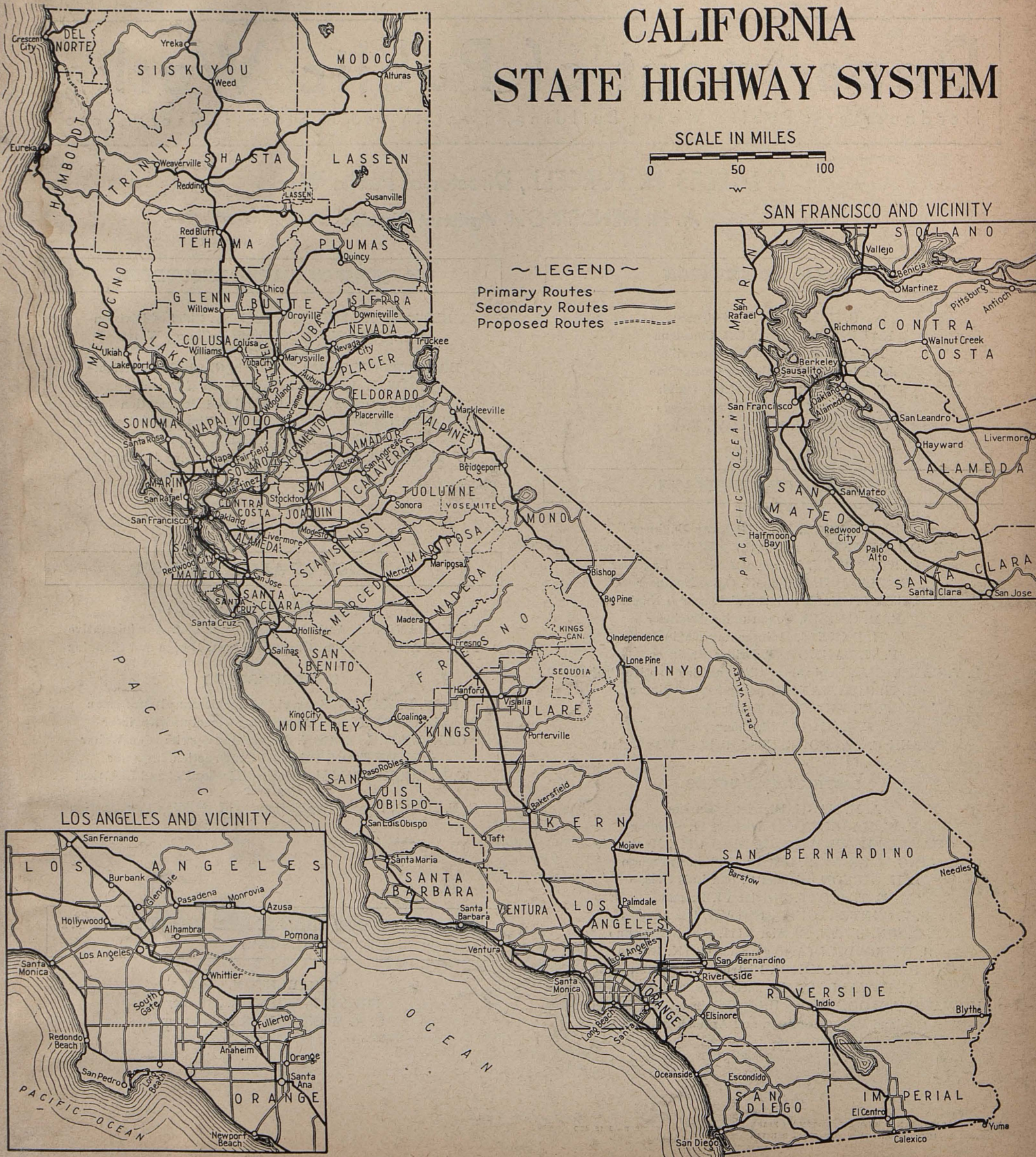


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CALIFORNIA STATE HIGHWAY SYSTEM



~ LEGEND ~
 Primary Routes ———
 Secondary Routes - - - -
 Proposed Routes - · - · -



D50 Illuminant, 2 degree observer

1	2	3	4	5	6	7	8	9	10	11 (A)	12	13	14	15
39.12	65.43	49.87	44.26	55.56	70.82	63.51	39.92	52.24	97.06	92.02	67.24	62.14	72.06	62.15
13.24	18.11	4.34	-3.80	9.32	-33.43	52.26	48.51	58.52	4.40	0.90	-0.75	1.08	-1.18	-1.07
15.07	10.12	-22.29	22.69	-24.49	5.93	-48.07	18.51	11.93	0.23	0.21	0.21	0.21	0.21	0.19
									0.04	0.09	0.15	0.22	0.38	0.51

Density

Golden Thread

100 200 300 400 500 600 700 800 900 1000

0.75 0.88 1.24 1.67 2.04 2.42

Colors by Munsell Color Services Lab

Die Williams