

California Highways and Public Works

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State of California



BLOSSOM TIME
ALONG A STATE
HIGHWAY IN THE
SANTA CLARA
VALLEY

APRIL - 1928



A PALM-LINED STATE HIGHWAY IN SOUTHERN CALIFORNIA

TABLE OF CONTENTS.

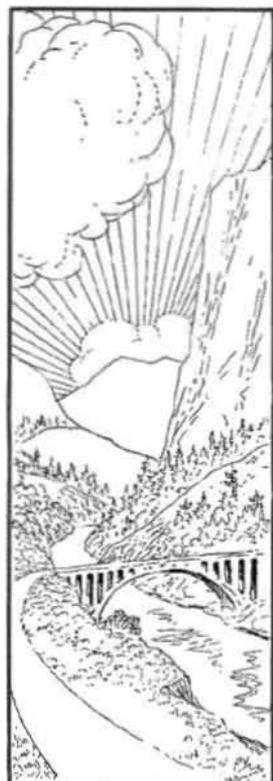
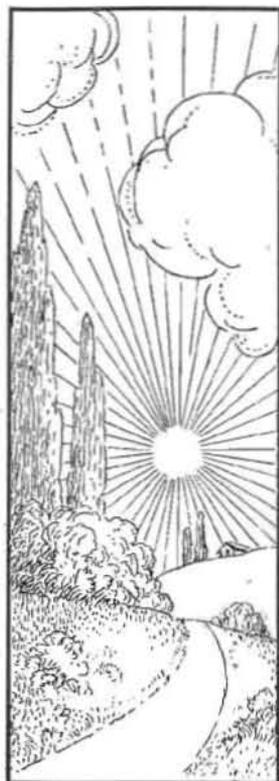
	Page
Front Cover Picture—Blossom Scene Along State Highway in Santa Clara County.	
Austin B. Fletcher, Highway Builder.....	1 and 2
How the State Highway Forces Met Emergency Following Dam Disaster.....	3
California's Message to Arizona.....	5
<i>By Commissioner J. P. Baumgartner.</i>	
Text of the Report to Governor Young on Causes of St. Francis Dam Failure.....	6
Solving San Francisco's Road Problems.....	8
<i>By J. H. Skeggs, District Engineer.</i>	
A Whole Town in One Institution.....	10
<i>By C. H. Kromer, Structural Engineer, Division of Architecture.</i>	
A Super Highway in Europe.....	11
<i>By C. L. McKesson, Research Engineer, Division of Highways.</i>	
Economics of Coordinated Water are Studied by Legislative Committee.....	13
Unique Sierran Contrasts are Offered by California State Highway.....	15
<i>By W. A. Chalfant, Editor Inyo Register.</i>	
Editorial—Theories of State Highway Financing.....	17
Highway Policies in California.....	18
<i>By B. B. Meek, Director of the Department of Public Works.</i>	
Santa Barbara to Plant Trees Along Twenty Miles of State Highway.....	21
Traffic Recommendations of Supervisors.....	32
Communications.....	33
Text of Feather River Routing Report.....	36
Progress Reports from the Field.....	40
Water Permits and Applications.....	43
Back Cover Picture—Blossom Scenes on Desert Highways.	



A FLOWER-LINED STATE HIGHWAY IN NORTHERN CALIFORNIA

To the honored memory of
AUSTIN B. FLETCHER

State Highway Engineer of California
from 1911 to 1923, this issue of California Highways
and Public Works is dedicated



he task of pioneering the development of California's highway system was the work that fell to the lot of "A. B." Into these early roads, he built not only tested cement and proven asphalt, well wrought steel and good macadam; but more permanent and enduring than aggregate and metal, were his fine ideals of honest, able and efficient public service, which also became an integral part of the highways, forming a foundation upon which the present roads of California are the superstructure.

Mr. Fletcher lived to see the tree of his life-mature and fruit in an added happiness and an enlarged usefulness given to the whole people of California. What greater monument could any one build? What greater reward could any one ask?

Austin B. Fletcher, Highway Builder

By C. C. CARLETON, Chief of the Division of Contracts and Rights of Way, State Department of Public Works.

EASTERN dispatches on March 8th announced the passing of one of the most notable highway engineers of our time—Austin Bradstreet Fletcher, first State Highway Engineer of California.

Perhaps no modern road builder has a more impressive record of achievement than he. Certainly none has more greatly influenced the thoughts and methods of his associates and contemporaries.

Mr. Fletcher was born at Cambridge Massachusetts, fifty-six years ago. He was educated at Harvard University. From 1893 to 1910 he was secretary and executive officer of the Massachusetts Highway Commission which was considered a model in highway practices in the United States. In 1910 he was chosen as secretary-engineer for the San Diego County, California, Highway Commission after a careful consideration of the outstanding road engineers of America. In 1911 he was selected by Governor Hiram W. Johnson to head the first State Highway Department of the State of California, in which capacity he served until 1923. During this period he also served as Director of Public Works and President of the State Reclamation Board. Since 1923 he has occupied a responsible position as Consulting Engineer for the United States Bureau of Public Roads at Washington, D. C., which was his official residence at the time of his death.

Mr. Fletcher was particularly recognized as a great organizer and an adept in the selection of personnel. He had extraordinary discernment in his analyses of the character, qualifications and integrity of applicants for positions at his disposal.

It became his duty to assemble the initial engineering field forces at the commencement of state highway activities in California in 1911, and from the outset he endowed it with an esprit de corps which has probably been unequalled in any similar organization.

It is a remarkable fact that today, in 1928, every district engineer and practically every department head of the California Highway Commission has been brought into the organization and trained and developed by him. A host of others in public employment everywhere have been the beneficiaries of his tutelage.

It may be safely stated that no public executive in California ever had a more loyal and devoted staff than he during his long

tenure of the position of State Highway Engineer of California. His co-workers prized it as a privilege and a distinction to labor under so precise, systematic and cultured a friend and leader as Mr. Fletcher; indeed, from him they received a liberal education in the proper forms, niceties and methods of business management and engineering practice.

Mr. Fletcher was called to California because of his widespread reputation as a road builder and because he was considered big enough to establish precedents rather than to follow in the footsteps of other men. So well did he install system in California that few changes have been made or perhaps can be made in the engineering principles and standards devised by this far-seeing pioneer of highway development. His ideas and ideals will ever remain foundation stones of the organization structure of the State Highway Department of California.

He was a strict disciplinarian but tempered his discipline with such kindness and consideration that few stings were ever left and but few subordinates took umbrage at his endeavor, as he humorously expressed it, "to keep them in their own corrals."

To many who did not truly know him Mr. Fletcher was considered somewhat austere and aristocratic. He was a man of quiet dignity, worthy ancestry and scholarly accomplishments, and by some he was misjudged and by others misrepresented.

But to those who really knew him his human and engaging qualities were predominant and they feel a profound personal grief at his taking.

The writer first met Mr. Fletcher when he arrived in San Diego to undertake the construction of the first county highway system of San Diego County nearly two-score years ago.

He was then spoken of as a "typical" New Englander personifying the manners, culture and traditions of the east.

But he was to become a pathfinder in road building in the west. Western ways were new to him at first, but in the years to follow he adjusted himself to his surroundings and the closing statement may be safely ventured that could he now express himself he would prefer to be borne in mind by his friends in the west as a gentleman and a Californian.

How the State Highway Forces Met Emergency Following Dam Disaster

DAMAGE estimated at \$150,000 was suffered by the California highway system when the St. Francis dam failed at midnight on March 12th. Of this damage, however, approximately \$70,000 was represented in a bridge over the Santa Clara River, the replacement of which at another site had already been decided upon. The net damage to the state highway system, accordingly will be about \$80,000.

The flood placed a threefold responsibility upon representatives of the Division of Highways. The failure of the dam occurred at 11.58 p.m. At 2 a.m. Maintenance Foreman L. B. Prosper was notified at the El Rio maintenance station of the collapse of the structure and that a great flood was rushing down the channel of the Santa Clara River.

Mr. Prosper immediately summoned his crew and stationed men at either side of the bridge crossing the Santa Clara River to warn motorists of the coming danger and to throw barricades across the road.

This was the first task to be performed. A number of lives were undoubtedly saved by the efforts of the highway crew. The story is told, however, of one machine that refused to stop, apparently fearing a possible hold-up. Second came the duty of assisting in rescue work.

Third came the task of reestablishing communication into the flooded area that relief work might be facilitated.

In all three tasks members of the Division of Highways did their part ably and well,

reflecting credit upon themselves and honor upon the Department of Public Works.

FLOOD HITS MAINTENANCE STATION

Mr. Prosper was patrolling the Santa Clara-bridge when the rush of the flood first became audible. Fearing for safety of his wife in the maintenance cottage, he rushed to her aid. They drove east in their car just as a four-foot wall of water struck the El Rio

maintenance yard. This yard is located nearly a half mile from the east end of the Santa Clara River bridge.

Mud and debris were deposited everywhere over the maintenance yard. Road equipment was buried hub-deep in mud. Water filled the cellar of the cottage and soon flooded the interior of the house. Damage of the maintenance yard is estimated at \$2,000.

Between the maintenance yard and El Rio, about 3000 feet to the east, flood water crossed the highway depositing mud and debris on the pavement. The Santa Clara channel, over 2000 feet wide,

was filled to overflowing. The main force of the flood struck the west end of the bridge.

TETRAHEDRONS DEFLECT WATER

Standing directly in the path of the torrent a row of thirty tetrahedrons extended out from the river bank. These were struck by a wall of water 15 feet high.

This wall of water carried with it a mass of large, uprooted trees, telephone and power poles, portions of buildings and barns which had been destroyed by the flood, and this

COMMENDATION IS GIVEN TO HIGHWAY EMPLOYEES

By B. B. MEEK, Director of the Department of Public Works.

I AM most gratified at the prompt and intelligent manner in which District Engineer Cortelyou and the men associated with him in every capacity met the emergency that arose from the flood which followed the collapse of the St. Francis Dam.

Persons most closely associated with rescue and relief work have informed me that the early reestablishment of communication in the flooded area made possible by highway forces was a most important factor in their work.

While the destruction of life and property in this disaster occasions the deepest sorrow, yet it is good to know that in time of stress and danger the state has in its employment men of clear thought and quick action, men to whom the call of duty takes precedence over personal safety, and who have no regard for hours of labor when difficult tasks are to be performed.

The thanks of the Department of Public Works is due all of the men who labored so fearlessly and so arduously in the days and nights following this great disaster. It is this spirit that has made the Division of Highways of the State of California known and respected the nation over.

battering ram was at work for several hours in its attack on the westerly approaches of the highway and railroad bridges. The force of the rushing waters was so tremendous that the entire row of thirty tetrahedrons, weighing over 200 tons and laced together with seven lines of inch cable, was swung back a



Where the Santa Clara bridge was swept away.

hundred and fifty feet toward the river bank at the downstream end, pivoting about the heavy concrete anchor at the bank on the upstream end, which held firm.

The earth approach to the west end of the Santa Clara bridge was not damaged, the water being



The bridge three hundred feet down stream.

deflected by the tetrahedrons. The flood, however, topped the bridge floor by a foot and carried away 240 feet of the bridge and all of the concrete pile bents supporting it. A hundred feet or more of the bridge deck was thrown high on the west river bank where it lays intact over 300 feet from where it was displaced.



Section of pavement in the flooded area.

BANK PROTECTION HAS SEVERE TEST

It is worthy of note that this recently completed bank protection at the west end of the Santa Clara River state highway bridge near Montalvo in Ventura County, though damaged and badly displaced by the terrific flood, proved effective and prevented a damage to the state highway, to the Southern Pacific Railroad and to the abutting property, which, without this protection, would have been many times the original cost of the bank protection.

Except for the line of defense made by these reinforced concrete tetrahedrons, the rushing flood waters would have washed away many acres of fertile ground on the west bank of the river; would have washed away the earth embankments at the west end of the



Tetrahedrons thrown into the bank.

state highway bridge and of the bridge on the main "Coast line" of the Southern Pacific Railroad.

DISTRICT ENGINEER ON JOB

District Engineer Cortelyou was informed early Tuesday morning of the disaster and left immediately for Saugus. Field investigations quickly showed that the 200-foot steel truss span over the Santa Clara River had been entirely washed out. He immediately instructed his assistant to engage a pile driver and crew. Before leaving Los Angeles he communicated with Chas. E. Andrew, bridge engineer, who was in Los Angeles at the time. Mr. Andrew left immediately for the scene of the disaster to assist in bridge opera-



The temporary bridge.

tions there. District Maintenance Engineer I. S. Voorhees and Assistant District Maintenance Engineer E. T. Scott were also with Mr. Cortelyou.

Inasmuch as the Newhall alternate line contemplates the abandonment of the narrow steel truss span over the Santa Clara River and the construction of a wider bridge several hundred feet up stream with

(Continued on page 22.)

California's Message to Arizona

State Highway Commissioner Baumgartner Pleads for the Unity that Is Particularly Denoted in Bridges

The Department of Public Works and the Division of Highways was represented at the dedication of the Mecca-Blythe bridge on March 10, by J. P. Baumgartner, State Highway Commissioner. Mr. Baumgartner's address on that occasion follows:

IT IS with sincere pleasure and feeling of honor that I bring you the greetings, compliments and congratulations of the Department of Public Works and the Division of Highways of the State of California. In doing so I speak personally for Mr. B. B. Meek, the Director of Public Works, whose special representative I have the honor to be on this occasion. I have also been asked to represent personally and bring you the personal greetings of my colleagues on the California Highway Commission, Mr. Ralph W. Bull of Eureka, Senator M. B. Harris of Fresno, Mr. Fred S. Moody of San Francisco and Mr. Joseph M. Schenck of Los Angeles.

We have all looked upon this occasion as of great importance and significance. We regard this bridge as not only a physical link between the two great commonwealths of Arizona and California, but as a spiritual joining of our common interests and destinies. We indulge fondly in the hope that it will prove to be so. The only fly in the ointment is that the only California state highway leading directly to this bridge stops four miles east of it, and that the bridge was not built by Arizona and California as it should have been. I feel that I can promise that the California state highway will soon be extended east to the entrance of the bridge, and that I am justified in the prediction that, in the fullness of time, this and all other toll bridges and toll roads in California and Arizona will become state property and free to all traffic.

Arizona, as well as California, is an empire in itself; like California, is so vast in resources and territorial extent that its people know California and Californians know its people to a very limited extent. If I may be pardoned for what may seem, but is not intended to be, the sounding of a discordant note, I will venture the prediction that if the people of California and those of Arizona knew each other better we would not now be struggling against each other in a vitally

important matter in which we should be in full accord. And I believe I am not unduly optimistic in expressing the belief that in this matter and in all others wherein our destinies are or may be joined we shall soon come to be a civically and morally, as we are now an economically, united people of the great Pacific Southwest.

It would seem to be not unfitting for me to call the attention of those here assembled, especially those from Arizona, to the fact that California has planned to spend during the next two years very close to a half million dollars on the improvement of roads leading to this bridge. Our hope is that Arizona will not only meet us here and at all points and kinds of contact with good will and good intentions, but also at the earliest possible moment, at this point at least, with good roads. In this connection, I am not unmindful of the fact that in some of our interstate connections Arizona puts California to shame. I am happy to assure Arizona, and California as well, that definite plans have been made and money has been budgeted for improving, very soon and very materially, all of our interstate connections on the California side.

California's state road-building program contemplates the expenditure during the ensuing biennium of very close to fifty million dollars in reconstruction, new construction and maintenance of roads; and the work to be done during the same period by the counties of California will bring the state's total investment in roads for the biennium up to about one hundred and sixty million dollars.

To my way of thinking, a bridge like this is a marvelous thing. I like to think of life in terms of bridges. Bridges connote connections, not severance. They mean easy, safe and economical intercommunication. They are socially and morally constructive as well as industrially and commercially so. They provide that vital thing we call contact—not physical contact alone, but the finer contact that produces the spiritual spark. And bridges mean beauty. At least some of them do and all of them should. It is almost a crime to build an ugly bridge, especially in California or Arizona, where most bridge settings are so beautiful. Our bridges should

(Continued on page 25.)

Text of the Report to Governor Young on Causes of St. Francis Dam Failure

THE COMPLETE text of the report submitted to Governor Young by the Board of Inquiry appointed by him to investigate the causes leading to the failure of the St. Francis Dam at midnight on March 12th is herewith printed. The report represents the unanimous opinion of the engineers and geologists comprising the Board of Inquiry. In receiving the report Governor Young called public attention to the fact that the members of the board, comprising some of the most eminent engineers and scientists of the nation, had served without compensation, thus placing their report, in the words of Governor Young, "upon an exceptionally high plane of public service." Members of the Board of Inquiry were: A. J. Wiley, chairman, Consulting Engineer, Boise, Idaho; Geo. D. Louderback, Professor of Geology, University of California, Berkeley; F. L. Ransome, Professor of Economic Geology, California Institute of Technology, Pasadena; F. E. Bonner, District Engineer, U. S. Forest Service, and California Representative Federal Power Commission, San Francisco; H. T. Cory, Consulting Engineer, Los Angeles; F. H. Fowler, Consulting Engineer, San Francisco. The report follows:

Los Angeles, California,
March 24, 1928.

The Honorable C. C. Young,
Governor of California,
Executive Offices,
Sacramento, California.

SIR: Your commission to investigate the causes leading to the failure of the St Francis Dam assembled in Los Angeles on the morning of March 19, 1928, and was met at the state offices by Mr. Bert B. Meek, Director of Public Works, and Mr. Edward Hyatt, State Engineer. The initial session of the commission was called to order by Mr. Meek as your personal representative, who delivered your instructions as follows:

"Not only California, but all the nation, has been appalled by the dreadful calamity which has befallen the beautiful little Santa Clara River Valley in Los Angeles and Ventura counties. This is a matter in which there are obviously three parties at interest—the stricken area of the two counties, the city of Los Angeles and the public at large. All of these are obviously equally anxious to learn all of the facts connected with this disaster.

I accordingly feel that it is a duty of the state to assemble a commission of eminent engineers and scientists to investigate the causes leading to the failure of the St. Francis Dam.

The prosperity of California is largely tied up with the storage of its flood waters. We must have reservoirs in which to store these waters if the state is to grow. We can not have reservoirs without dams.

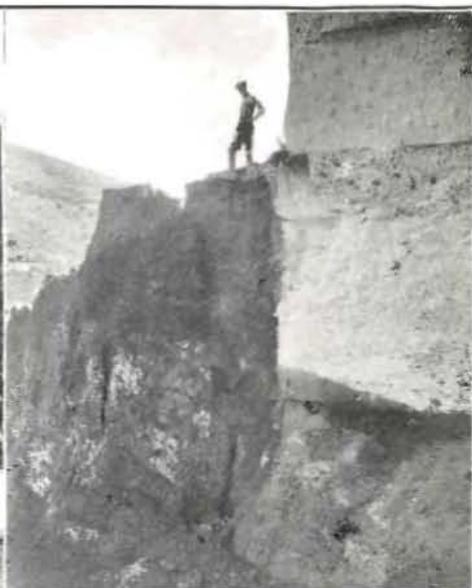
These dams must be made safe for the people living below them. All this is both elemental and fundamental.

Accordingly our duty is a double one. We must learn, if it is possible, just what caused the failure of the St. Francis Dam; the lesson that it teaches must be incorporated into the construction of future dams. There must be no repetition of this catastrophe if it is humanly possible to prevent it."

Guided by such instructions, the commission has carried out its investigations in field and office. Mr. Meek and Mr. Hyatt have held themselves constantly available for consultation and aid, and it is only through their assistance that the commission has been able to complete its work within such a limited time.

Through the cooperation of Mr. Wm. Mulholland, chief engineer and general manager of the Bureau of Water Works and Supply, city of Los Angeles, your commission has been furnished plans, photographs and other data concerning the design, construction and operation of the St. Francis Dam. These data include the results of certain measurements and surveys made after the disaster.

Independent surveys and measurements were made for the commission by the forces under Mr. S. V. Cortelyou, District Engineer of the California Highway Commission. The state highway force also secured all test specimens selected by your commission, and preparation and testing of the specimens were



Upper left, The St. Francis reservoir before the collapse of the dam. Lower left, Scene at the dam site following the failure of the structure. Note the portion of the dam left standing and the white markings on the stream bed which denote the height that the water reached as it rushed down the stream. Upper right, Scene at brow of west wing showing cross-sections of formation upon which dam was built.

carried out under the direction of Mr. W. A. Perkins, hydraulic engineer of the State Engineer's office. Mr. Perkins also prepared the table of discharge deduced from the chart made by the water register on top of the dam.

Geological conditions at the dam site have been the subject of careful study by Dr. George D. Londerback, and by Dr. F. L. Ransome, members of the commission.

DESCRIPTION OF ST. FRANCIS DAM

Construction of the dam was begun in April, 1924, and the structure completed May 4, 1926. It was located on San Francisquito Creek in section 1, T. 5 N., R. 16 W., San Bernardino meridian, between San Francisquito Power House No. 1 (upstream) and Power House No. 2 (downstream). The reservoir created by the dam was primarily for terminal storage near the lower end of the Los Angeles Aqueduct which conveys water from the Owens River region. Incidentally it was expected ultimately to catch the run-off from the San Francisquito Creek drainage area above it, of approximately 37 square miles. Legal rights to do this, however, had not been secured, and it is understood that such local waters were passed through the reservoir. The drainage area

above the dam, and the location of the Los Angeles Aqueduct and power plants with relation to the streams, highways, etc., are shown on the map. A profile of the nearby portion of the aqueduct, including the St. Francis Dam and reservoir, is shown. It will be observed that water which passed to St. Francis reservoir could not be utilized through Power House No. 2.

The dam was of the solid gravity type, curved on a radius of 500 feet to the upstream face at the crest. Its right or westerly end was continued by a wing wall which followed in general the crest of a narrow ridge, finally terminating at a high point about 500 feet from the end of the main dam; a small gap beyond this point was closed by a low concrete wall. The maximum cross-section, and a plan of the dam (including wing walls, etc.) Maps and plans furnished by the Bureau of Water Works and Supply show that the crest thickness of the dam was 16 feet, and the maximum section was 205 feet high and 175 feet thick at the base. The batter of the upstream face changed from 1 in 27 to 1 in 10, and finally in the extreme bottom to $3\frac{1}{2}$ in 10. The downstream face was carried up in a series of steps uniformly 5 feet high, and with widths varying from 5.5 feet near the bottom to 1.45 feet near the top. The length of the main dam measured along the center line of

(Continued on page 25.)

Solving San Francisco's Road Problems

By J. H. SKROGS, District Engineer, San Francisco.

THE first unit of the state's portion of the Bayshore is now being advertised. It is the section from San Francisco to South San Francisco on new alignment and grades and consists of heavy grading with temporary surfacing pending settlement, the cost of the 4.36 miles to run well over a half million dollars.

The second section, South San Francisco to Broadway Station, Burlingame, as graded in 1926 by D. R. Foley and Company, has been in an unsurfaced condition. Since the South San Francisco underpass is completed a contract was let in December to Granfield, Farrar and Carlin for regrading and surfacing with rock. This job is well under way, the grading nearly completed and the rocking well started.



J. H. SKROGS.

Rains have been the deciding factor on this job as on account of the material used in subgrade, in wet weather heavy trucks can not work. With the laying of rock this is overcome and it is expected that the job will proceed at a fast rate. Upon completion of rock surfacing a final surface of oil treatment of a bituminized macadam will be placed before opening to traffic.

REALIZATION OF LONG DREAM

The third section from Broadway Station, Burlingame to Fifth avenue, San Mateo, is to be advertised in the near future and it can be said that the dream of years, a wide road with easy grades to relieve the Peninsula highway and accommodate the expected heavy trucking to the new industrial sites along the water front, is no longer merely a dream but well on its way to realization.

THE BROKEN BOTTLENECK

The much-discussed Bottleneck through Colma and the cemeteries has not only been broken, but has been trimmed up, smoothed out and beautified until it not only meets the traffic needs but as recently completely paved by Hanrahan Company it is a pleasure to the driver and is an engineering accomplishment over which any engineer might justly feel proud.

COORDINATING CONSTRUCTION AND TRAFFIC

The construction of the pavement on this contract was an example of coordination of plans for construction and traffic needs. It was constructed in a series of 10-foot strips, placed in pairs where possible and the program so arranged that at all times the old pavement, several short rock detours, and the newly constructed strips were so combined that traffic was inconvenienced so little that it was often remarked that the confusion was even less than that on the old road before the job was started. Consisting of two 30-foot concrete pavements separated by a 28-foot curbed-in strip used by the Market Street Railway it does away with confusion of two-way traffic, safeguards the traffic from street car interference and meets the requirements of the heaviest traffic of any highway in the state, that of approximately 29,000 cars in a 16-hour count.

SKYLINE BOULEVARD

The Skyline boulevard is again on the construction program. Since the bond issue funds were exhausted, little has been done on this highway except to oil and rock it under maintenance crews.

The constructed section extends from San Francisco along the hills adjacent to the ocean to a junction with the La Honda road at the summit between the ocean and Woodside.

This accommodated the daily traffic and week-enders whose destination was the beauties of La Honda or way points.

With the advent of the additional one-cent gas tax, funds are available to continue this road; accordingly it is expected that bids will shortly be invited and if satisfactory a contract let for grading and surfacing this 14-mile stretch which extends from the La Honda road to Saratoga Gap which will afford a new and continuous route from San Francisco to the city of Santa Cruz via the California Redwood Park and the town of Boulder Creek.

VALLEY ROAD CONNECTIONS

The state highway connecting San Francisco and the East Bay cities with the San Joaquin and Sacramento valleys is rapidly approaching a standard that will meet increasing demands of tourist and truck traffic.

Before and After Colma Bottleneck was Broken



The installation of rock shoulders from the northerly boundary of Alameda County to Livermore by maintenance forces, and the completion of 9 miles of second-story concrete pavement 20 feet wide, from Livermore to Dublin, by Contractor Ball, have led up to the Dublin to Hayward section, which is now under contract by Ariss-Knapp Company of Oakland. This road is being widened, alignment and grades improved, and rock surface placed, while at the same time three concrete arch bridges are being built at line changes by Contractor E. B. Skells.

CONSTRUCTION "PROGRAMMED"

The system of programming long jobs is well proved on this contract. The contract was let with the stipulation that as the job would last over the winter, certain work was to be done before the winter rains to allow of a systematic control of traffic and the carrying on of that part of the work during the rains that would least interfere with traffic. This has been done. The section from Dublin to three miles westerly toward Hayward has been graded and rocked. Heavy cuts at a point three miles west of Dublin, known as Bulmer

(Continued on page 31.)

A Whole Town in One Institution

Something of the Wide Range of Duties that the Division of Architecture Covers

By C. H. KROMER, Member American Society of Civil Engineers, Structural Engineer, Division of Architecture.

THE TASK of building a whole town in one institution is the job that confronts the Division of Architecture in planning the construction program of the larger institutions of the state.

This is true because these state institutions in large part are in the nature of small municipalities. A few facts will illustrate this.



C. H. KROMER.

The population of state hospitals is approximately 2000 each. San Quentin—the larger of the two state penitentiaries—has a total population of over 4000 people and is gaining an average rate of three prisoners a day. Folsom has a population of approximately 2500 people. Other state institutions have

larger populations than many of the smaller incorporated cities of California. Thus in planning a construction program for one of these institutions the Division of Architecture must meet the engineering requirements demanded of the city engineer, together with the requirements demanded from an architect.

MORE THAN BUILDERS

But this is not all. The Division of Architecture is not concerned alone with building. Consideration must be given to care for the physical well-being of the wards of the state; to providing them with heat, light, hospital facilities, workshops, cooking and dining facilities, places for the care and repair of clothing, and a large number of other activities that in the town are met by specialized service.

The Division of Architecture accordingly must be a specialist in the general practice of the profession. The state architect must know how to build industrial plants of various kinds. Brick-making plants, gas-making

plants, machine shops, laundry, mechanical and electrical plants, as well as a score or more of other industrial establishments, come within the range of his activities.

In addition to being an industrial engineer the state architect must also be a practical farmer with expert information on how hay barns, silos, dairy and other farm buildings should be built.

This is only part of the story. He must be an expert on kitchen construction and refrigeration equipment. And his information on this subject must represent the very latest thought in the architecture and planning of dietary institutions.

Nor does this end the tale. Institutions must be heated. Water must be provided. Sewage systems must be laid out. Irrigation plants must be developed. And in general the Division of Architecture must plan a state institution in all the details needed in the life of a municipality.

HOW THE WORK IS DONE

It is of interest to know how this is done and the care that is taken to guard against mistakes.

At the head of the Division of Architecture, which is an integral part of the Department of Public Works, is the state architect. An assistant chief of the Division is in charge of all designs, and a deputy chief is in direct charge of the administrative and financial work of the Division.

In order that it may more efficiently provide the services demanded of it the Division is divided into Architectural, Clerical, Estimating, Construction and Engineering sections; but in carrying out the various prerogatives of the Division the sections are actually further subdivided into the following units: Architectural Designing and Drafting, Specification Writing, Structural Engineering, Estimating, Engineering (Mechanical, Electrical and Civil), Construction and Clerical. In addition there is an Accounting Department maintained in connection with the Division of Engineering and Irrigation and the Division of Water Rights.

Four designers and two assistant designers,

(Continued on page 23.)

A Super Highway in Europe

By C. L. McKesson, Material and Research Engineer, Division of Highways.*

THIS very unusual highway project 42 miles in length extending from Glasgow to Edinburgh, in Scotland, is of unusual interest in that it is probably one of the most expensive pieces of road construction ever undertaken. It has been carefully designed to meet the designs of modern high-speed interurban traffic. In type of construction it exemplifies the most approved European construction.



C. L. McKesson.

COST OF QUANTITIES

Some idea of the magnitude of the project will be conceived from the following table of costs and quantity: The total estimated cost is \$10,878,262.64 including \$1,776,272.50 for bridges and \$942,962.24 for lands. The average construction cost, exclusive of bridges and right of way is about \$195,000 per mile. Excavation of soft material 2,150,000 cubic yards; excavation rock 67,000 cubic yards; weight of Telford base 300,000 long tons; weight of surfacing 153,000 long tons; length of drains 82½ miles; maximum depth of cut 24 feet; maximum height of embankment 44½ feet.

ADJUSTABLE BRIDGES

The road traverses a rather sparsely populated section and passes through several villages but no large towns or cities. Most of the road is on new location although old routes have been utilized for a portion of the way. Coal mining has been carried on for many years in the region traversed by the road and subsidence of the entire countryside occurs from time to time. This unusual condition has been taken into consideration in the design of bridges which have been made adjustable by keeping the deck separate from the abutments in such places and by providing recesses in which hydraulic jacks can be

*This is the first of a series of articles by C. L. McKesson, Material and Research Engineer, Division of Highways, giving his impression and observations of road practices and some additional engineering features gleaned during a trip through the British Isles and France, with a brief side trip into Germany. This trip in so far as road inspections were concerned covered approximately 2000 miles of automobile travel.

placed for the purpose of raising the bridge deck from time to time as this becomes necessary. In one or two places where the coal has not already been mined the highway authorities purchased the coal "in place" from the owners with the understanding that it be allowed to remain and that lowering of the road be thus avoided.

SEPARATE TRAFFIC LANES

In the design of this improvement the engineers took into consideration the prob-



Telford base under construction.

ability of urban development along the new route. They also took into consideration the difficulty which has been encountered in Europe and elsewhere in getting traffic to utilize to the best advantage a roadway con-



Section of finished roadway on the Glasgow end. Sidewalks are of tar macadam. After the Telford base is thoroughly locked and filled, the road is surfaced with three inches of tar and macadam.

taining a large number of traffic lanes. Experience on some very wide pavements near London had indicated that it is very difficult to secure a distribution of traffic on excessively wide roadways. As a result of their observations the engineers who designed this

work have planned that the entire improvement ultimately have two traffic lanes, each 30 feet in width.

DETAILS OF DESIGN

On approximately four miles adjacent to Glasgow the roadway has been graded to a width of 120 feet between slopes. The typical cross-section shows two 10-foot sidewalks, a 5-foot parking on each side for service pipes, two 30-foot roadways with a strip in the center 30 feet in width which it is expected may be used by an electric railway. On the next 31 miles the road is being graded to a width of 100 feet between slopes and one 30-foot roadway is constructed with one edge adjacent to the center line. The cross-section also shows an 8-foot sidewalk. On this section it is planned that future development, when required, will include the construction of another 30-foot roadway separated from the first by a curb along the center line of the road.

In general, the road is to have a Telford foundation about 12 inches in thickness placed in a cinder subbase.

An accompanying picture shows the Telford base under construction. A very heavy concrete curb has been constructed along each side of the roadway extending to the full depth of the Telford base. This curb serves as a foundation for a 6-inch by 12-inch stone curb which projects above the roadway with a 6-inch curb face.

The other picture shows a section of the finished roadway on the Glasgow end of the project. The sidewalks are of tar macadam. After the Telford base is thoroughly locked and filled the road is surfaced with 3 inches of tar macadam which is to be followed, after traffic has used the road for a time, by a 2-inch covering of asphalt concrete. This type of construction appears massive compared with some of our thin reinforced road slabs but it is, in general, typical of the practice that has prevailed on important roads in France and Germany for many years. It is due to this heavy but more or less flexible base that it has been possible to build up road surfaces which successfully withstand continuous traffic, practically without load limit. It is nothing unusual to see heavy steam-driven trucks with net loads of 30 tons or more traveling at high speed.

In this connection it is interesting to note that while such extremely heavy loads are permitted on the highways that the freight cars on the railroads carry only 8 to 10 tons.

The surfacing on this road, first of tar macadam and then of asphalt concrete, is also more or less typical of English practice.

On some of the new grade reinforced concrete base is being constructed. This base has a cinder and stone subbase and is itself in reality a very substantial pavement. It is laid in 20-foot panels with reinforcement top and bottom. The panels are constructed alternately and a reinforced concrete beam is built under each transverse joint. The concrete is 8 inches in thickness and of 1-2-4 mix. This very rugged concrete pavement is to have a cover consisting of 2 inches of asphalt concrete. It will be noted that the total thickness including subbase reinforced concrete and asphalt wearing surface is 18 inches.

STORM DRAINS

A storm drain system is being installed and catch basins provided throughout the entire route for handling storm water. Considering the great width of the improved roadway and the heavy type of construction it is not at all surprising that the total cost of this road should reach the stupendous average of \$250,000 per mile. On the section adjacent to Edinburgh the total estimated cost is \$369,854 per mile.

INTERSECTIONS

The chief engineer has given much attention to the proper design of intersections and also to the matter of securing proper sight distances on vertical curves. The intersections, where completed, under this plan had a very pleasing appearance and seemed to insure reasonable sight distance.

SIGHT DISTANCE ON VERTICAL CURVES

The following is quoted from the chief engineer's description of the design of the vertical curves:

"Vertical curves at sags are to be parabolic. The length of the curve is to be generally 150 times the algebraic difference of the grades per cent (equivalent to a circular curve of 15,000 feet radius). Vertical curves at summits are to be parabolic. The length of the curve is to be 120 times the algebraic difference of the grades per cent (equivalent to a circular curve of 12,000 feet radius) except at bridge or other crossings where it is necessary or desirable to keep down the amount of banking, where a length of 80 times the algebraic difference of the grades per cent is desirable and a length of 50 times will be the ultimate minimum (equivalent to a circular curve of 8000 feet and 5000 feet radius respectively). With such vertical curves at summits, the minimum lengths of the line of sight to the horizon from a point in a motor car 5 feet above the ground are respectively 346.4 feet, 282.8 feet, and 223.6 feet, and the distances at which two motor cars 5 feet high become mutually visible are 692.8 feet, 565.6 feet, and 447.2 feet."

This important highway project is conducted under the general supervision of Sir Henry Maybury, Chief Engineer of Trans-

(Continued on page 24.)

Economics of Coordinated Water Are Studied by Legislative Committee

HEARINGS upon economic and financial phases of the proposed plan for the coordination of the water resources of California were held by the joint legislative committee in San Francisco on February 20, 21, and 22, and in Sacramento on March 16th.

The large attendance at these meetings and the interest shown in the hearing evidenced the importance that the people of California are attaching to the investigation of the water resources of the state and the effort to solve the problems attached thereto.

The discussion at the San Francisco hearing, lasting over three days, centered about the following subjects:

1. Physical features of the plan and the first unit suitable for development.
2. Suggestions for financing the project.
3. Plans for distributing the power that the various projects would generate.
4. The rapidity with which an attempt should be made to make the plan in part at least effective.

OTHER ISSUES

At the Sacramento hearing the morning session was devoted chiefly to the consideration of the plan as its affected mountain and foothill counties. The questions at issue had particular reference to the reservation of a portion of the water falling upon and originating in these counties for the use of lands located therein.

The afternoon session, which consisted of a conference between the Legislative Committee and the members of the Sacramento-San Joaquin River Problems Conference, developed an entirely new angle in the discussion of the problem. Members of the latter conference committee urged the importance of a program that would afford early relief to the delta lands and thus overcome objection to the diversion of water in the Sacramento and San Joaquin valleys.

PHYSICAL FEATURES OF THE PLAN

This phase of the subject centered chiefly about the relative merit of the Kennett and Iron Canyon projects.

Representatives of the manufacturing interests along Carquinez Straits and Suisun Bay declared that while 3500 second-feet released into the delta of the Sacramento and San Joaquin rivers would solve the salinity problem as far as farm lands in the delta were concerned, it would not give the industries the large supply of cheap water upon which they stated their successful operation depended. Speakers declared that the growth of California up to this time had largely been the result of the development of agriculture through irrigation. Future growth, it was predicted, would depend upon the growth of manufacturing. This in its turn was declared to be dependent upon the presence at manufacturing sites of large supplies of cheap water.

Speaking upon this phase of the matter Mr. Warren McBryde stated that nowhere in the world was there a landlocked harbor with large supplies of fresh water so close at hand as was the case with San Francisco Bay. To make that supply available, he declared, that a barrier must be erected.

Mr. McBryde also urged the importance of developing industry as a market for the power that would be produced under the coordinated plan. He estimated that \$15,000,000 would be available for the construction of a barrier, if the earnings as a highway toll bridge were capitalized; and that another \$15,000,000 would be available from its use as a railroad bridge. The damage to industries to date from the invasion of salt water was placed at over \$25,000,000.

The importance that the industries of the section attach to the barrier was evidenced by the announcement that they had employed Thomas S. Means to make a study of the economic phase of the barrier construction.

SUGGESTIONS FOR FINANCING

There were a number of suggestions for financing, all of which contemplated a substantial income from power sales. Representatives of power companies indicated their willingness to take over the power load if it could be acquired at a cost not greater than they would have to pay for that privately developed. It was also pointed out that the

generation of power by steam is now lower in cost than that developed by water, owing chiefly to the low cost of oil.

The question of whether or not any part of the cost could be levied on agricultural land developed a difference of opinion among representatives of agriculture there. Against the statement of one spokesman that the entire project would have to be financed without charge to farm lands, another spokesman declared that some farmers must prepare to spend more money upon their land than they now are spending or their condition would get worse rather than better. A resident of the lower San Joaquin Valley stated that in that area pumping plants and equipment in that district, represented an investment of \$25,000,000 for which the farmers were paying. He declared that the plan for coordinated use of the water of the state would mean a huge saving in pumping equipment to landowners of the southern San Joaquin Valley.

There were recurrent suggestions of a state bond issue to cover the cost of the initial development. One speaker suggested that the state issue bonds with certain designated and benefited districts and areas upon which the burden of their repayment would fall.

One suggestion was that the state adopt a plan by which water would be sold at cost less the power income. This same speaker declared that there should be an actual reservation of water in any reservoirs that might be built to take care of the future irrigation of lands in the Sacramento Valley and their adjacent foothill areas. He suggested that a very nominal standby charge might be made against these lands for this water reservation.

A plan advanced by another speaker was that the project be divided between the federal and state governments; that the former assume the cost of the Iron Canyon project and the latter the cost of such other units as might be included in the initial development.

Mr. W. H. Holmes, representing the Modesto Irrigation District, declared that the dams constructed by irrigation districts along the east side of the San Joaquin Valley had helped fresh water conditions in the delta by equating the flow of the river. It was his opinion that these districts should be given credit for this in any plan for financing a state-wide plan that might be adopted.

DISTRIBUTION OF POWER

Power loomed up large in all discussions as to financing. The method of distributing power was the occasion of the chief debate of the entire proceedings. Franklin E. Hichborn urged that the committee study the Ontario plan, and advocated state distribution of power in the manner advocated in the Water and Power Act. He urged that distribution of the power by the state should be included as an essential part of any plan, and that no attempt should be made to do anything with the plan unless means and methods had been perfected for the immediate distribution of power by the state.

L. A. Bartlett of Berkeley followed Mr. Hichborn. His plea was that cities be allowed to buy state-generated power. He suggested that high-duty power lines be made public carriers, thus assuring competitive rights to power users. Mr. Bartlett stated that he was unwilling to go as far as Mr. Hichborn in asking that nothing be done until state distribution of power was assured. He urged, however, what he

termed the essential importance of the sale by the state of actual kilowatts as against a sale to private power companies of the privilege of generating power. In this matter Mr. Bartlett also urged a sale of power, if made to private companies, on a year-to-year basis.

THE TIME ELEMENT

Many speakers urged that the time element was a controlling factor in the whole plan. John S. Drum declared that the state was now acting 10 years after the time that this plan should have been made effective. Speakers from the lower San Joaquin also urged the importance of having a report with a recommended plan ready for submission at the next meeting of the legislature.

Against this, other speakers declared that the legal phases of the plan had not been considered, and that sufficient time must be taken for a thorough study of its every phase.

A number of speakers voiced the thought that the important thing to do was to develop a complete plan which could be carried out on a unit basis, and into which each development would have its proper place.

Fred H. Tibbetts voiced an objection to "proceeding too fast," declaring that the plan might be used, but only if this danger of overhaste was avoided. The salinity problem, he stated, was not getting worse but would get better. He also stated that there was sufficient water in the streams for present irrigationists in the Sacramento Valley. The industrial problem, he predicted could be solved by the construction of a dam at Fall River on the Trinity River at a quarter the cost of a salt water barrier.

ASK LOW HEAD DEVELOPMENTS

At the Sacramento hearing the method suggested to secure the early relief required was that low head developments for the storage of water should be given precedence over high head projects. The lower cost of such low head developments, their greater accessibility, and the less time that would be required for their construction were cited as evidence of the fact that they would give the relief desired before such relief could be secured from more extensive projects such as the Kennett Dam.

To assure the priority of such lower and cheaper development in the construction program of public utility companies, members of the conference urged that the law be amended to empower the Railroad Commission to select the sites and locations for dams and decide project priorities in the construction program of public utility corporations. The exercise of such power is justifiable, so its proponents urged, on the ground that the State Railroad Commission should take all uses of water into consideration, and that the use of water for the generation of power should not outweigh all other uses.

Specifically the conference committee named the Folsom Dam as one that could be built immediately. The Iron Canyon and Trinity River dams were also suggested as structures that would fit into such a plan.

Objections to the proposed low head development were urged as follows:

First, high head dams develop cheaper power than low head projects;

Second, if the cost of the hydro power is materially increased, the companies will be forced to the use of steam power, and water storage by public utilities will largely cease.

The statement was made that the cost of generating power as between hydro and steam plant is so close now, that while hydro power is cheaper in Oakland than steam power, the reverse is true in San Fran-



 INYO SCENES

The Old
Order
Changeth
Giving
Way
To The
New

Unique Sierran Contrasts Are Offered by California State Highways

By W. A. CHALFANT, author of "The History of Inyo County," and "The Outposts of Civilization," and editor of the *Inyo Register*.

TO RIDE in comfort along the base of a two-mile-high snow-capped range, "the crown of California," as one visitor termed it; to have a try at skiing, snowballing and winter sports; to view some of America's noblest scenery mantled in its winter whiteness, while the beholder basked in balmy sunshine; to dip into a warm and delightful plunge under a midwinter sky; to enjoy high-class accommodations and a never-lagging hospitality and welcome—such were some of the details noted by something over a score of guests of the Bishop Chamber of Commerce, during a winter sight-seeing tour to Owens Valley and the high Sierras February 11, 12 and 13.

Tens of thousands of people know the Sierras in their summer aspect; comparatively few know of their winter sublimity or the comfortable enjoyment of that spectacle. The tour was planned on nonprofit lines, to introduce those charms to a new public. Every Los Angeles newspaper, its chamber of commerce, tourist bureau and motor transit companies were represented in the company of travelers. A comfortable big motor bus was the means of travel.

Leaving Los Angeles on the morning of the 11th, the party reached Little Lake for lunch. The day's journey, past the chemical plants on the shore of Owens Lake, through Lone Pine, and past the bases of Mount Whitney, Mount Williamson and other towering peaks, ended at Independence, where a dance in honor of the visitors preceded their repose at the modern Winnedumah Hotel.

Bishop was reached early the next day, and the noted Kittie Lee Inn became the base of operations. Citizens had private cars ready to convey every one to Mammoth, center of scenic interest. There lunch, provided by the chamber of commerce, was ready, and afterward cars took passengers on another mile or so to where snow unbrokenly covered the ground.

Return was made for the night. An item of the entertainment available was a display of films of the beautiful series of mountain pictures, motion and stills, to which J. W. Bledsoe, veteran photographer, has devoted some years of labor. As it happened, the theater's regular program at the time included one of the many movies "westerns"

filmed (wherever the scene is supposed to be laid) in Owens Valley and vicinity.

While in Bishop, some of the visitors hunted up some of the local novelties. One of these is a bar said to have cost \$8,000, which originally decorated Tex Rickard's noted Goldfield "Northern" saloon. Another novel industry of which they learned is a "fish-worm" farm—an enterprise not so fishy as it sounds, for the small boys of the vicinity collect an aggregate running into hundreds of dollars yearly by the sale of "garden hackle" to tourists who rely on that time-tried bait rather than on the fancy flies affected by the aristocracy of anglers.

On Monday, February 13th, the more than delighted sightseers left for their fields of labor, stopping on the way for the enjoyment of a plunge at Keough Hot Springs, and a complimentary lunch at Lone Pine.

Every visitor was enthusiastic over his or her experience on the brief outing, and a dozen or so of them committed their opinions to writing. Such phrases as "wonderful hospitality, most gorgeous country, marvelous time, marvelous people, wonderful trip and climate, majestic splendor of the high Sierras," are samples from that symposium.

Among the items praised was the wonderful roads leading to the high Sierras scenic region. In that he points out a factor of prime importance in making the country better known, in the vast improvement of its southern approach. Time was when an auto trip from Los Angeles lacked much of being enjoyable. One by one the drawbacks have been overcome. Corkscrew roads have been straightened, and courses changed to eliminate needless distance. Surfacing and oil have supplanted loose gravel and sand. What has been already done has practically cut traveling time between Los Angeles and Owens Valley in two, while the discomforts have been reduced in more than equal proportion. Other sections of California have road improvement also, but probably there is no other equally long drive in which the contrast between the past and the present is more marked. Improvements still go on, under the able direction of Division Engineer Somner, for whom his district has only the highest commendation.

It was dusk as she stopped at the roadside filling station.

"I want a quart of red oil," she said to the service man.

The man gasped and hesitated.

"Give me a quart of red oil," she repeated.

"A quart of r-r-red oil?" he stuttered.

"Certainly," she said. "My tail-light has gone out."

Chief Solano Will Sleep Undisturbed By Modern Traffic

Progress executed a right flank movement in deference to sentiment, in order that the bones of an aboriginal American hero may lie undisturbed.

Square in the middle of the right of way of line changes just ordered by the California Highway Commission between Rockville and Cordelia, Solano County, stands a lone buckeye tree, a living monument to the mouldering remains of Chief Solano of the Suisun tribe. Solano County was named for the old chief, who rates as one of the most heroic and best regarded Indians of pioneer days in California. Few of his tribesmen remain, but a number of years ago, the buckeye tree, one of the first brought to California, was planted on his grave by Solano citizens as a testimonial to Solano's friendliness to men and women of the Caucasian race.

Completion of state highway changes between Rockville and Cordelia will soon result in thousands of cars thundering by the lone buckeye, but Solano will sleep undisturbed.

Highway Officials Adopt Resolutions of Respect

The following resolution was adopted by the Western Association of State Highway Officials, which was in session in Los Angeles at the time of Mr. Fletcher's death:

WHEREAS, Austin B. Fletcher, one of the founders of the Western Association of State Highway Officials, passed away at Washington, D. C., on March 9, 1928; and

WHEREAS, Mr. Fletcher was one of the notable highway engineers of the United States, embodying in his life both the high ideals of his profession and its outstanding service to state and nation; therefore be it

Resolved, That the Western Association of State Highway Officials extend to the relatives of Mr. Fletcher in their great sorrow, the heartfelt sympathy of its members; and expression be given to the sorrow that the members of this association feel in the loss of a personal friend and a most honored and able member of their profession; be it further

Resolved, That a copy of this resolution be spread upon the minutes of the Western Association of State Highway Officials as a lasting tribute both to a life well lived and to a career, a monument to which are better highways the nation over.

"Listen," remarked the exasperated driver over his shoulder, "Lindbergh got to Paris without any advice from the back seat."

CALIFORNIA HIGHWAYS AND PUBLIC WORKS.

Official journal of the Department of Public Works, State of California; published for the information of the members of the department and the citizens of California.

Editors of newspapers and others are privileged to use matter contained herein. Cuts will be gladly loaned upon request.

BERT B. MEEK.....Director
GEORGE C. MANSFIELD.....Editor

Address communications to California Highways and Public Works, P. O. Box 1103, Sacramento, California.

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THEORIES OF STATE HIGHWAY FINANCING

THE QUESTION

1508 Chestnut St.,
Philadelphia, Penn.

Department of Highways,
Sacramento, California.

Dear Sirs: I am preparing data on the subject of the maintenance of principal or state highways through the medium of gasoline and motor vehicle taxes solely.

Kindly advise me what policy your state pursues in this connection and what your general opinion is regarding the matter. If you have issued any publication dealing with the subject I will appreciate your sending me several copies thereof.

Awaiting your convenience, I remain

Very truly,

ROBERT MAYER.

THE ANSWER

To which the following reply was made:

The present policy of California is that state highways are financed solely through the imposition of taxes on gasoline and fees upon motor vehicles. In the early days of our state highway history, roads were built through funds derived from bond issues.

In our opinion the method of financing highway construction depends largely upon the era of highway building in which a given state finds itself and the attitude of the public of that state toward good roads.

Thus the bond issue method in the early period of California's good road development was undoubtedly the best plan to finance the construction of improved roads, running into what was then considered a very large cost per mile. In fact it was probably the only method that could be used, as the number of registered motor vehicles and the consumption of gasoline in highway transportation was then so small that it would not have yielded sufficient income even to have made a start upon any program that would promise

an adequate state highway system. Bond issues made a large sum of money immediately available, enabled a state road system to be under way in a comparatively short time and by actual demonstration educated the people in the knowledge that good roads pay for themselves with big dividends added. The bond plan also enabled the cost of these early roads to be spread over the generations that will enjoy them and profit by them. Nor will these later paying generations be injured, as the roads that are being and will be turned over to them are an asset far greater in value than the debt that they will be called upon to pay.

This early period, however, in California's road history is past. In public affairs as in private business, it is foolish to borrow money when payment can be made from cash in hand. The number of motor vehicles has increased from 28,600 in 1909, the year that California voted its first bond issue, to 1,736,765 in 1927. The gasoline used in motor vehicles in California totaled 1,071,680,000 gallons in 1927. It will thus be seen that the uniform charge of \$3 levied upon passenger cars, in California, with a graduated fee upon trucks, together with a tax upon gasoline, yield a sum that enables California to build and care for its roads on a pay-as-you-go plan.

While it is true that interest on bonds should be considered as part of the operating costs of highways and not as a capital investment, and that the book cost of roads is the same whether built with borrowed money or paid from existing reserves or income, yet this is largely a matter of bookkeeping technique. The fact remains that the taxpayers are little concerned as to whether the saving made by the pay-as-you-go plan is credited to construction or operation as long as the money remains in their pockets. The saving in interest charges to California taxpayers by the cash payment plan as compared with the issuance of bonds amounts to many millions of dollars annually, and constitutes a very real reduction in the cost of state government.

To put the matter briefly: California's experience is that good roads, properly located and well constructed, pay whether built with borrowed money or paid for with cash. It is good business to pay cash if you can. It is poor business to go without the roads, if a bond issue will make them available.

There are only two really important questions before the American people today—how to pay and where to park.—*Exchange*.

Highway Policies in California

Director of Public Works Tells Outstanding Features of State Road Administration

By B. B. MEEK, Director of the Department of Public Works, State of California.

THE highway history of California may be divided into three periods. The first period dealt chiefly with construction activities. The second was characterized by the development of better and more adequate maintenance methods. The third period, upon which we have now entered, should be marked by both activity in construction and adequacy in maintenance.

California pioneered the way among the states of the nation in the construction of improved highways. Unfortunately the word "permanent" instead of the word "improved" was used in popularizing these early roads. The impression created was that improved roads, even without proper maintenance, would prove permanent in fact as well as in name.

The result of this false impression as to the permanency of surfaced roads was that maintenance allotments as compared with the mileage of improved highways became increasingly inadequate. When the roads gave evidence of impairment under the traffic that they themselves had created, the people awoke suddenly to the fact that highways that they had considered as indestructible were breaking down. The public was startled and confused. And yet looking back over that period and with the knowledge that we now have, the wonder is that the narrow and thin pavements stood up as well and as long as they did under the unexpected traffic. In fact many miles of these early pavements are still in service.

CONTRIBUTION OF EARLY BUILDERS

The contribution of these early builders of California's highways was a threefold one:

First, without precedent to guide them or experience to teach them, a pavement was designed that for years carried a traffic far greater than the most enthusiastic of early day good road's promoters predicted.

Second, this pavement was generally so designed that it could be widened and thickened without the loss of the original investment, when the surface began to break under the stress of traffic.

Third, the narrow and thin pavements then built made possible a highway mileage that

in its turn accustomed and converted the people to the gospel of good roads.

SECOND PERIOD

The second period of our highway history, from which we are just now emerging, was characterized rather by the development of adequate maintenance methods than by the extension of improved highways.

Brought to a realization of the fact that improved highways were not of necessity "permanent" roads, the public also realized that these roads were worth to the state many times the combined total of their construction and maintenance cost. Money for adequate maintenance, including widening and thickening operations, was voted by a law levying a two-cent tax on gasoline. Increased traffic also made necessary a better alignment of highways than was required during the earlier period when the traffic volume was less. The work both of maintenance and realignment was ably performed.

A further notable improvement of this second period was the separation of many highway and railroad grade crossings by the construction of overpass and underpass structures. In other instances grade crossings were eliminated by relocating highways on an alignment that avoided track crossings. There is still much of this work to be done, but an excellent beginning has been made.

NOW ENTERING THIRD ERA

With revenues for new construction again made available through the one-cent gasoline tax enacted by the last legislature and approved by Governor Young, we are now very definitely entering upon the third period of our highway history. This period should include the outstanding features of the two earlier periods. It should be one of construction activity coupled with adequate maintenance.

Those of us in whom responsibility for the administration of our state highway system is now vested, should profit by the experience of the early road builders. We must prepare for a traffic far greater than that which now exists. In building methods and highway

policies, we must look both backward and forward.

In building for the future, however, we must not forget that we also owe a duty to the present. Mr. Fred S. Moody, member of the California Highway Commission, put this matter very succinctly in an article dealing with California's mountain highways. Referring to the change from bond issues to gasoline taxes in financing road construction, Mr. Moody well said: "We are building our roads on a pay-as-you-go plan, and the people who are footing the bills should be entitled to road service within their life time." I heartily concur in this statement.

TEN COMMANDMENTS

I might summarize outstanding phases of present highway policies in the following Ten Commandments of California road building:

1. The present highway system must be completed within as short a time as is compatible with sound engineering and economical construction. We want haste, but not the kind of haste that makes waste.

2. The inclusion of new roads into the state system should be postponed until such time as the present system nears completion.

3. Adequate provision for future development should be assured both through providing wider rights of way NOW, and through reserving for public use areas adjacent to the highways of particular scenic charm or recreational value.

4. On roads where present traffic is not heavy, a low cost surface should be provided that will adequately care for the existing travel, and which will become a part of a well-packed base, when future traffic demands a larger pavement investment. Our recommendation for this class of highway is the oil and rock surface, known as the California type pavement.

5. Relocation of roads should be made where it is possible to eliminate grade crossings by such realignment. An agreement should be reached between state highway and railroad officials for a definite cost-sharing policy in the construction of grade eliminations and grade separations.

6. Repair on our highways must be immediate and continuous. Every maintenance man in our work must also be a minute man. Regular traffic counts and studies must be made to determine traffic trends and to enable present roads to be widened and thickened in advance of deterioration or destruction.

7. The routing of present unlocated roads by "the most direct practical route" as prescribed by law and as determined by experts, trained and skilled in this work, must govern in all location matters. In the words of Governor Young, location of our highways must be determined "by traffic pressure rather than by political pressure."

8. Highway funds are to be budgeted for each biennium in advance of their expenditure. Suggestions and proposals for highway financing outside of and in addition to present revenues should be discouraged. Our present income we hope will be adequate and if we spend it wisely we believe will be continuous.

9. Construction of toll roads for through traffic should be discouraged. This is the business of the state and counties.

Illuminated Railroad

Grade Crossing Signs

Realizing that the hazard at railroad grade crossings is much greater at night than during the day, R. E. Pierce, Acting District Engineer of District Ten, with headquarters at Sacramento, has installed a number of



illuminated signs at various main line grade crossings in this district.

Two crossings have been so protected at Tracy for some time, and the comments from people who travel this stretch of highway have been so favorable that we have just completed the installation of signs at two more grade crossings, namely, Hatch crossing south of Modesto and McConnell crossing south of Sacramento.

10. Construction should be by contract rather than by day labor, unless the bids of contractors are unreasonable.

In conclusion: The State Department of Public Works will spend over \$50,000,000 during the present biennium.

We intend to see that these millions are spent legally and prudently and in a manner consistent with good public policy.

Further we intend that the people shall know *in advance* just where we are spending this money, just how we are spending it, and why we are spending it as we are. It is their money. As stockholders of the State of California, they are entitled to authoritative information as to where, how and why their money is spent. CALIFORNIA HIGHWAYS AND PUBLIC WORKS, the official journal of the Department of Public Works, is issued to give this information to the people.

If I might characterize in one phrase the policy outlined above, I would say that it is one of partnership between the people of California and the authorities charged with responsibility for the construction and maintenance of the state highway system; a partnership that has for its object the building and betterment of the state that it is the great privilege of all of us to serve.

CALIFORNIA HIGHWAYS

The highways are an endless chain

That lead from here to there,
With no beginning and no end
But reaching everywhere.

On concrete ribbons smoothly laid

A million motors glide,
The work of engineering skill
And California's pride.

Throughout this realm of scenic charm

On every hand they go,
From Shasta's view in Siskiyou,
To mystic Mexico.

Here orange groves with vineyards vie

And fruitful orchards bloom,
While towering to the vaulted sky
Great snow-capped mountains loom.

Where can be found such wondrous scenes

Amid a clime supreme?
A paradise for motorists
Beyond their fondest dream.

The tourist from the icebound East

Finds here relief and rest,
With welcome to a sun-kissed land
And highways of the best.

—Charles L. Tompkins.

A "Model" Application

Below is an exact copy of a letter received in one of the districts of the Division of Highways from an applicant for an engineering position.

"This morning I left my formal application in your office. Look it over. There is some good experience represented thereon—experience which I have profited by. While on the U. S. Geol. Sur. I was considered "plenty good"—one of the best recorders and rodmen of my time. I was accurate, speedy, and neat. Not long ago I applied for a certain engineering position but was sensible enough to turn it down as I did not know some necessary methods for the efficient discharge of my duties. It hurt like hell to have to give up—but it did not daunt me! I went home and learned the method; and this has a direct bearing upon my applying to you. What I do not know, I'll soon learn. You will never regret employing me. Remember that when you need your next man.

"While I prefer to remain in the office on account of being married and having a small family, I will readily go into the field whenever you deem it necessary. I know the adjustments and uses of the transit, level, plane table and theodolite; being most skillful with the level. When you need your next subordinate, notify

Yours truly,

"You want a man—
I want a job
You have the job—
And I am the man!"

SOME DEFINITIONS OF ENGINEERING TERMS

This list of definitions was compiled by R. W. Emery of Cleveland, Ohio.

DRAFTSMAN—A man who puts his ideas on paper for the boss to change.

CHECKER—A man with a blue pencil but without a conscience.

TRACER—A slave who, knowing nothing himself, never understands what the draftsman thinks he knows.

BLUE PRINT BOY—A skunk with a dirty neck, who smokes cigarettes and occasionally makes a blue print.

TOOL DESIGNER—A collection of erroneous ideas surrounded by a boss.

DRAFTING ROOM—A place where time between arguments is spent making drawings to be changed.

DATA BOOK—A collection of information that no one needs.

TRACING—A piece of linen used to take the high spots off of erasers.

ENGINEER—A mechanical genius who spends his time thinking up ideas which he refuses to recognize when he meets them on a drawing.

"LIZZIE LIZ"

(With apologies to Kipling's "Gunga Din")

By JOHN HOWE ENCELL, fifteen-year-old son of Harry A. Encell, attorney for the Division of Highways.

You can talk of all your cars,
And say that mine is full of scars;
But I'd like to see you beat mine on the hills.
My heap is funny lookin',
And she stands a lotta 'jokin',
And when it's cold the driver always gets the chills.
Although the brakes are almost gone,
And there's not a shop where she would pawn
She is mine, and I will keep her, Lizzie Liz.
Oh, it's Liz, Liz, Liz,
You chuggin' lump of scrap tin Lizzie Liz.
You are makin' such a racket
You just rattled off a bracket;
For Gawd's sake get a goin', Lizzie Liz!
You guys may think it's funny
When I call my Lizzie "Honey,"
But it's just a little coaxin'
That she needs.
You can swear and you can cuss,
Or even kick my little bus,
But a few kind words is all she ever heeds.
You can talk of Chevrs and Stars,
And all those kind of cars,
But I'll keep my little Lizzie Liz.
Oh, it's Liz, Liz, Liz,
Friend Henry's gift to Scotland, Lizzie Liz;
I tell the boys I drive you slow
When it's really all you'll go;
I wouldn't hurt your feelin's, Lizzie Liz.

"Are you fond of autos?"

"Am I? Say, you should see the 'ruck I ate for lunch."—*Business Builder*.

Santa Barbara to Plant Trees Along 20 Miles of State Highway

PLANS for the immediate planting of shade trees on twenty miles of the Coast highway, from Elwood to the county line at Rincon in Santa Barbara County, have been outlined by a committee of Santa Barbara citizens headed by George A. Black.

The committee recommends that the first planting should be done between a point two miles east of the residential portion of Carpinteria and to the Elwood road near the railroad station known as Elwood, 12 miles west of the city of Santa Barbara. The evergreen trees recommended comprise six varieties of blooming evergreens and three varieties of evergreens without blooming qualities.

There will be thirteen sections along the line of highway to be planted.

The *Cupressus montezuma*, a fernlike evergreen, has been selected to be used between old town, Carpinteria, and the concrete bridge west of Carpinteria, while the beautiful jacaranda, with its slightly leafy foliage and blue trumpet flowers, will start where the *Cupressus* stops and will continue through the residential section of Carpinteria to the east bridge, and from that point easterly the pink-blooming eucalyptus will be used to the fork of the roads north of the Sattler tract of land.

Later, the planting will be continued with a species of tree to be selected, over the remaining one-half mile to the west line of Ventura County but not until the new highway between the two points is graded. From old town to Toro Canyon road, through Serena Park section, where excellent soil conditions prevail, the scarlet-blooming eucalyptus, the handsomest of the eucalypti will be planted.

From Toro Canyon road to the approach to Summerland the silvery blue eucalyptus will be used; through Summerland *Acacia melanoxylon* has been selected; over the new road at Ortega Hill the fantastic, wide-spreading *Cupressus macrocarpa* will be used to the lower lands. At the approach to Montecito to the east city limits of Santa Barbara, the

same tree as used at Serena Park, the scarlet-blooming eucalyptus, will be used.

From San Roque road, along the south side of San Roque Park to La Cumbre avenue the orange, large-bloom acacia will be used. From San Antonio road to the east end of the Lombardy poplars, planted years ago by George S. Edwards, the cream-colored acacia is designated. From the west end of the Lombardy poplars and through Goleta to the concrete bridge the golden-orange acacia is recommended. From the bridge, through West Goleta to Fairview avenue the magnolia is chosen and from this avenue to the east line of Corona del Mar the *Casuarina stricta* is named, and from that point to Elwood station the pink-blooming eucalyptus is to hold sway.

All of the trees in the list are hardy, and many varieties are quick growers.

The entire planting of the evergreens will be done and supervised by the state, as well as the care, irrigation, staking, preparation of soil and fertilization. Leveling of roadways when essential will be undertaken by the men of the Maintenance Department of the Highway Commission, and replacements, if required at any time after the first year, will be paid for and the work done by that Commission.

The Highway Commission will require that a fund representing \$2.25 per tree shall be in the hands of the County National Bank and Trust Company, and that either the trees or sufficient money to buy them also be provided. When this is done, work can be started.

It is the plan of the committee to plant 70 trees per mile in alternating formation on the two sides of the highway, with 150-foot intervals. The cost per mile is \$200. The initial cost is all the communities will be called upon to pay. After the first year, the Highway Commission takes over the planted trees and guarantees to maintain and replace trees that may not survive, or may be destroyed through roadway accidents.

A committee composed of Ralph T. Stevens, E. O. Orpet, Lockwood de Forest, Jr., and George A. Black, chairman, has completed a survey of the district to determine soil and wind conditions preparatory to selecting the best trees. H. T. Campbell, a nurseryman, and Otto Niedermuller, a landscape gardener, assisted in the survey.



GEORGE A. BLACK.

HOW STATE HIGHWAY FORCES MET EMERGENCY FOLLOW- ING DAM DISASTER

(Continued from page 4.)

a subway under the Southern Pacific Railroad in place of the existing grade crossing. It was decided that the proper step to take would be to build a temporary pile trestle across the Santa Clara River on the same alignment as the old bridge. This would make possible utilization of the heavy piers of the old bridge and the south girder which was intact. Mr. Andrew and his assistants immediately ordered material for this work.

Arrangements were made with the representative of the Los Angeles County Road Department to open a temporary road over the Santa Clara River on the old county road alignment to handle traffic for a few days until the trestle bridge could be constructed.

SAN FRANCISQUITO BRIDGE

The river was so high on Tuesday morning that no definite information could be obtained regarding the San Francisquito bridge. The following morning it was learned that the three 60-foot steel girder spans had been washed down stream; that the abutments were intact except that the concrete was broken on the top; that the flow in the San Francisquito River had dropped to a point where the quickest way of taking care of traffic was to put a temporary road through the stream channel far enough up stream so that it would not interfere with the reconstruction operations at the bridge site.

Upon hearing of the disaster, M. L. Sullivan, superintendent of shovel operations on the Ridge road immediately worked his way south to the flooded area. He reported to District Engineer Cortelyou Tuesday morning and was instructed to get his crew, as well as that of Foreman McCullough's crew, immediately at work clearing the roadway north of the Santa Clara River bridge. Later these crews built a detour around the San Francisquito bridge.

ROAD GAP IS BRIDGED

Maintenance Foreman Harbey and his crew worked valiantly in rescue work and in temporarily bridging a washout. A small shovel was sent up to the work on Wednesday to start refilling the washout and the shoulders between Saugus and the Santa Clara River crossing. This washout was 45 feet wide and 20 feet deep and was caused by backwash from the flood. It was of first importance to bridge this gap so that the various utility reconstruction crews and the relief forces could more readily reach points further down the stream. It was also necessary to close this gap to enable a pile driver and lumber to be delivered at the Santa Clara River bridge site.

Fortunately the Maintenance Department had on hand at the Saugus yard practically enough old bridge timber to throw in a temporary structure about 12 feet wide. The crews worked until about 9 o'clock in the evening, completing the bridge in one day. Light traffic crossed it that same evening. The following morning the bridge was further strengthened so that heavy loads of lumber crossed it the second day.

HOURS OF LABOR NOT CONSIDERED

The state maintenance and construction forces responded nobly to the duties that they were called upon to perform. H. H. Brown, employed with Foreman Harbey worked twenty-four hours on March 13th, sixteen hours on March 14th, and twelve hours on March 15th. The balance of the crew worked thirteen

hours on March 13th and eleven hours on March 14th. Mr. Harbey, himself, worked twenty hours on March 13th, eighteen hours on March 14th and twelve hours on the 15th.

In addition to efforts of state crews in the district, two caterpillar tractors with operators and one heavy dump truck were detached from work and sent across the river from Fillmore to Bardsdale there to engage in the relief work at that point. This was at the request of Mr. A. R. Heron, Director of Finance, who was on the ground representing the State Administration in rescue work. Although the working day was completed when word reached the men operating the tractors and truck they immediately started for Bardsdale with their outfits and reported for immediate work there between 9 and 10 p.m. The location and surveying crews in this vicinity also cooperated to the utmost.

MAJOR DAMAGE ITEMS

The major items of damage are the loss of the Santa Clara River steel span bridge, 200 feet long, and the loss of the three through-girder type spans totaling approximately 180 feet at the San Francisquito channel. Evidently the flood with its load of drift swept down on the Santa Clara River bridge, probably topping it. High water marks are observable to a height of at least 15 feet above the roadway at this point. This bridge was swept from its piers. The piers, however, were all left intact. The secondary short span on the southerly end was also left in place. Later the steel truss was found cast up on the west bank about a half mile down stream in a compact-twisted manner.

The north and south abutments of the San Francisquito bridge were left in place, also practically undamaged. The four intermediate cylinder piers were destroyed, and the three spans were deposited at various angles anywhere from 200 to 500 feet down stream. A superficial examination indicated that these spans are not badly twisted out of shape and possibly they may be salvaged for future use.

At this latter bridge approximately 110 feet of pavement was lost at the southerly end and some 80 feet of pavement at the northerly end. The embankment in each place was washed out to a depth of 80 feet.

Serious loss of embankment were suffered at several other places. The total replacement of embankment is estimated at approximately 12,000 yards. In addition to this the pavement was covered near the southerly end of the Santa Clara River bridge with a deposit of sand totaling approximately 450 yards. North of the San Francisquito bridge in the vicinity of Custaic Junction there were two other stretches of pavement covered with sand and necessitating the removal of approximately 4600 yards.

EMERGENCY WORK ORDER SIGNED

Immediately upon receipt of information as to disaster and its consequent damage to highways Director B. B. Meek of the Department of Public Works made a \$30,000 emergency work order available for reconstruction activities. Additional allotments will be made as estimates of the damage become available.

WORK OF TETRAHEDRONS

The part that the tetrahedrons played in averting greater damage than was suffered has attracted wide attention.

Standing directly in the path of the torrent, the bank protection, consisting of a row of thirty reinforced concrete skeleton tetrahedrons, extending out from the river bank to deflect flood water under the main bridge and protect the west approach, was struck by a torrent fifteen feet high.

(Continued on page 25.)

A WHOLE TOWN IN ONE INSTITUTION

(Continued from page 10.)

all under the direct supervision of the assistant architect, care for the architectural design for, and planning of, all building structures, as well as for the landscape architecture required in connection therewith. A complete understanding of the project in hand is obtained by visits to the site and full discussions had with the head of the institution, his assistants and any others who may be directly concerned. Architectural studies and complete preliminary sketches and estimates are then made and conferences continued until the plans are satisfactory and within the money available. A corps of architectural draftsmen working under the direction of a chief draftsman then prepare the working architectural plans and details, make full size drawings in connection therewith and prepare miscellaneous requisition drawings. The Division so functions that whenever one section is unduly busy, drafting assistance is rendered by members of other sections.

The specification writer, with the aid of two assistants, prepares all specifications with the exception of those relating to the engineering portions of the work, and in connection therewith passes upon the acceptance of materials. He also prepares and handles all contracts in connection with the work of the Division.

The structural engineer, with the assistance of a corps of assistant structural engineers and draftsmen, prepares designs, makes working and requisition drawings, checks shop details for all of the structural work of the Division. Examinations are made in order to determine the stability of existing structures and recommendations as to the necessity for alteration, repair, or condemnation. Actual tests of strength of construction, bearing value of soils by means of excavations, loading and pile tests to determine the proper method of supporting the structures are made. These structures are many and varied, such as buildings, underpasses, culverts, towers, tanks, sewage treatment and disposal plants, retaining walls, reservoirs, dams and other water works structures (until the time of the formation of the Department of Public Works, utility, flood control, and similar public dams and reservoirs were checked for the State Engineer), the acceptance or rejection is recommended for all structural materials furnished in connection with the work, shop fabrication and tests of structural materials supervised, proportions

for concrete mixes determined and other related work performed. These problems necessarily involve a familiar knowledge of all materials and their properties used in structural-construction work, whether in wood, steel, masonry or reinforced concrete.

The Estimating Section, in charge of the Engineer of Estimates and Cost, makes complete preliminary as well as final estimates of cost for all projects proposed or undertaken by the Division, and lists and purchases all material for force account work (the final estimates are used as a check on the contractor's bid). If it is found advisable to undertake any work on a force account basis this section also lists and requisitions all materials required and is responsible for deliveries of the material to the job at the right time.

The mechanical, electrical and civil engineering work of the Division is carried on by a corps of mechanical, electrical and civil engineers and draftsmen, under the direct supervision of an engineer with the title of "Engineer," assisted by a mechanical and an electrical engineer. This section prepares all drawings and specifications in connection with mechanical engineering for buildings such as plumbing, heating, ventilating and lighting, for all electrical installations, for power and water supply works, for sewage disposal. It prepares requisitions for force account work, makes surveys, and maintains a general supervision over mechanical installations of all kinds.

The Construction Section is directly responsible for the inspection of field work for contract as well as for day labor work. This work is in direct charge of the "General Superintendent," who is assisted by superintendents of construction and foremen. These assistants act as inspectors for the various contract jobs where construction is going on and as directors of construction for force account work. Where a job is handled by day labor, certain portions of the work are frequently let to subcontractors, and in these cases our representatives act both as inspectors and as superintendents of construction. All mechanics and laborers for the force account work are appointed direct through the medium of the Civil Service Commission.

The Clerical Section consists of stenographers, clerks and assistants.

INSTITUTIONS OF STATE

The Division of Architecture is responsible and active in the preparation of all plans and specifications and the supervision of all state building, as well as other public works

at the various state institutions throughout the state. These institutions include all of the state schools, with the exception of the University of California; such as the State Teachers Colleges, Polytechnic Schools, Schools for the Deaf and for the Blind, Corrective Schools for Boys and for Girls, the State Prisons, and State Armories, Veterans' Homes, Homes for the Feeble Minded, and the State Hospitals for the Insane. The Division is also active in the construction and engineering development of the various hatcheries throughout the state of the Fish and Game Commission, and other state enterprises, such as the State Buildings at Sacramento, San Francisco and Los Angeles; the State Printing Office at Sacramento, the Exposition Building and the Air Port at Los Angeles; the State Fair at Sacramento and other miscellaneous projects throughout the state. At the present time, the Division functions at thirty-three major state institutions, and, in addition, engages in some construction activity at approximately twenty-seven other places.

A SUPER HIGHWAY IN EUROPE

(Continued from page 12.)

port. The proposal of plans, details, and the construction of the work is carried on under the personal direction of Mr. D. A. Donald as chief engineer. It is to these gentlemen and to Mr. Wright, assistant engineer, that the writer is indebted for the information which he obtained regarding the project and for the opportunity to make this inspection.

Maintenance Foreman

Is Killed at Delano

On Wednesday, February 15th, Jesse Pettus, maintenance foreman at Delano, was killed by the explosion of an oil fuel tank on an asphalt kettle, while patching roads in his section.

Mr. Pettus had been with the state for seven years and was one of the most valued and trusted employes in District VI. The entire district mourns his passing and extends heartfelt sympathy to his wife and the five small children whom he leaves.

Card of Thanks

Delano, California, March 3, 1928.

Mr. E. E. Wallace, Division Engineer,
Highway Commission,
Fresno, California.

DEAR MR. WALLACE: I wish to express my most sincere thanks and appreciation for the kindness shown me by you and the employees of Division 6 during my recent bereavement.

Sincerely yours,

MRS. JESSE PETTUS.

ECONOMICS OF COORDINATED WATER STUDIED BY LEGISLATIVE COMMITTEE

(Continued from page 14.)

cisco. In the Los Angeles region, he stated, steam power is cheaper than that produced by hydro plants.

While this condition was attributed to the low cost of oil, it was stated that coal could be substituted for oil, if the latter increased in price and the price for steam power kept at its present level.

The outlook for a season of low rainfall was urged by the speakers as a further reason for adopting a plan that would have as its most essential feature early relief from present conditions. Speakers stated that a year of low rainfall would mean that the Antioch suit would be pressed, and that the litigation would not only disturb values but would impose a burden running into hundreds of thousands of dollars upon the litigants. The cost of the suit at the present time was said to total \$300,000.

THE FOOTHILL SITUATION

Representatives from a number of counties were present to discuss the coordinated plan as far as it affected the interests of counties with large bodies of mountain foothill lands.

Assemblyman R. E. Dillinger of Placerville urged the necessity of a water reservation for these counties sufficient to take care of the agricultural lands within their confines. Unless this was done, he declared that the time was coming when the foothill and mountaineers would find that their supply of water had been lost to them with nothing left for their own development.

The provisions of the so-called Dillinger bill were discussed at length. Mr. Dillinger stated that the bill provided for a maximum reservation of fifteen per cent of the water originating within any county. The actual reservation, he stated, was to be determined by the amount of land that could use water with profit.

D. Fricot of Calaveras County urged that the importance of an adequate supply of water for the development of the mineral, timber and other industrial resources of mountain counties.

Opposition was voiced by the representatives of mountain counties to the imposition of any time limit, during which water reservation, if made, would have to be used or its rights to use it in the county lost. It was contended that the valley areas used this water only when economic conditions made its use profitable, and that the same rule should apply in the case of mountain counties.

The importance of water in the streams of mountain counties as a recreational attraction was also urged. Members of the legislative committee are Assemblyman Bradford S. Crittenden, Tracy, chairman; Senators Ralph Swing, San Bernardino; W. R. Sharkey, Martinez; H. C. Nelson, Eureka; Edward A. Mueller, El Cajon; Assemblymen E. G. Adams, Livingston; Frank W. Mixer, Exeter; Van Bernard, Butte City.

Judge Luce Named to

San Diego Port Position

B. B. Meek, Director of the Department of Public Works, has appointed Judge Edgar A. Luce to the position of Surveyor of the Port of San Diego, effective March 1, 1928.

HOW STATE HIGHWAY FORCES MET DAM DISASTER

(Continued from page 22.)

Six of the thirty tetrahedrons, those located most centrally in the low water channel and which had become partially imbedded in the river bottom during a previous flow of water, were torn to pieces by the torrent, snapping and breaking the 12 foot by 12 foot heavily reinforced concrete legs of the tetrahedrons. Having their bases imbedded in the sand and being fastened to adjacent tetrahedrons with seven lines of one-inch cable, the six tetrahedrons were pulled apart as the fourteen tetrahedrons downstream from them were swept toward the river bank.

With six broken and the others badly displaced, the row of thirty concrete skeleton tetrahedrons came through the most tremendous flood that ever rushed down the river channel. They were constructed to prevent flood waters from cutting through the west approach to the bridge, and accomplished their purpose. The earth approach to the west end of the bridge was not damaged, the water being deflected by the tetrahedrons to its proper course under the bridge. Large quantities of brush and trees were collected by the protection work, and the area remaining between the row of tetrahedrons and the river bank and also on the stream side of the protection was silted up with about four feet of sand and gravel, thus straightening the channel and leaving conditions better than before the flood, as far as the river channel itself was concerned.

CALIFORNIA'S MESSAGE TO ARIZONA

(Continued from page 5.)

be so designed and built as to become a part of the colossal scheme of sculpture that was in the mind of the Creator when the earth was in the making. Beautiful bridges are an economic as well as an aesthetic asset. California and Arizona should never profane the majesty of their mountains by building any other kind.

I like to think of my work on the California Highway Commission in terms of bridges—prolonged bridges that reach out from either bank of the streams they span to the farthest confines of our great state—and on and on across the borders of the state into Arizona and into Nevada and into Oregon—and on and on and on to the uttermost confines of the continent—and, in terms of time, on down through the ages.

In a magazine the other day I read a story of a governor who, being childless and stricken with fatal disease, sought reelection that he might build a beautiful bridge to perpetuate his name. And I thought of Stephen Gerard who, at 82 years of age said, "If I knew I should die tomorrow I would plant a tree today." Reaching back from the brink of the grave to place the germ of life in the womb of the earth! Truly a gallant and defiant salute to death!

REPORT TO GOVERNOR YOUNG ON CAUSES OF ST. FRANCIS DAM FAILURE

(Continued from page 7.)

the curved crest was 700 feet. The elevations above sea level at various points of the structure were as follows:

Crest of parapet	1,838.06 feet
Crest of spillway lip	1,835.00 feet
1st outlet upstream invert.....	1,799.00 feet
2d outlet upstream invert.....	1,763.00 feet
3d outlet upstream invert.....	1,727.00 feet
4th outlet upstream invert.....	1,691.00 feet
5th outlet upstream invert.....	1,658.26 feet
Bottom of maximum section.....	1,620.00 feet

Both faces of the crest of the dam were vertical for 23 feet. The downstream face of this vertical section was divided into panels 24 feet wide, of which eleven panels in two groups were spillways. Each spillway panel was 20 feet wide by 1.5 feet high clear inside dimensions. The five outlet pipes each 30 inches in diameter, were controlled by sliding gates fastened to the upstream face of the dam.

Storage of water in the reservoir began March 1, 1926. The approximate maximum storage for 1926 was 13,200 acre-feet at elevation 1779 on June 5. This level was maintained until about August 10, gradually lowered until October 5, and held thereafter at about 1762 until the end of the year. After January 5, 1927, the water was raised at a uniform rate to 1832 on May 10, where it was held until May 27. It was rather rapidly lowered to about 1817 June 20, and then with minor variations brought down to 1813 November 8, after which the level was raised to 1821 by December 31, 1927. From the beginning of 1928, when the water surface was 1821, storage was increased gradually until March 5, when the reservoir was practically filled to capacity of 38,000 acre-feet. The water level was maintained at 1834.75 or 0.25 feet below the spillway crest, until the time of the failure at 11.58 p.m., March 12, 1928.

Photographic evidence and the testimony of witnesses show that little seepage passed through the structure of the main dam. Certain cracks developed in the main structure, which possibly discharged an unimportant amount of water, as is not at all unusual in concrete dams. One or more cracks, with consequent unimportant seepage, also developed in the wing wall extension to the west of the main dam.

Much more important seepage is reported to have taken place through the foundation upon which the dam rested. As the water rose in the reservoir this foundation seepage appears to have increased to a maximum of between one and two second-feet on the afternoon preceding the failure. Rumors of muddy water seeping under or around the dam before its failure are in circulation, but the commission has been unable to verify them.

FAILURE OF THE DAM

It is reported that one of the caretakers was seen on top of the dam at 11 p.m. only an hour before the failure, and apparently up to this time there had been no alarming developments. The caretakers were lost in the flood, and so far as is known there is no living witness of the dam's collapse.

The first indication of failure, given by the automatic water register located on top of the central or standing section of the dam, was a gradually accelerated falling of the water surface, starting about 11.30 p.m. (corrected time) and aggregating about three-tenths of a foot at about 12 p.m., when the

failure was indicated on the record by a rapid fall in the water surface.

At 11.58 p.m. there was a break in the Borel transmission line of the Southern California Edison Company which was located in the canyon immediately below the dam. At 12.30 a.m., March 13 the power from the Los Angeles city power plant No. 2 in the canyon about one and a half miles below the dam went off.

It appears that the failure of the dam took place at, or slightly before, 11.58 p.m., March 12, when the main dam structure, with the exception of a section near its middle, failed completely, leaving the greater part of the left or easterly portion in very large fragments at and just below the dam site and great blocks of concrete up to about 10,000 tons in weight, chiefly from the right or westerly end, distributed for a distance of several thousand feet downstream.

The magnitude and violence of the wave released on the failure of this dam are hard to visualize even by engineers familiar with floods and flood conditions. The rush of water attained a maximum depth of about 125 feet in the deepest of four sections measured by the commission within three-fourths of a mile below the dam. In the vicinity of San Francisquito Power House No. 2, approximately 1.5 miles along the channel downstream from the dam, an even greater depth was reported. The flood wave completely carried away the heavy concrete power house down to the generator floor, together with the less substantial buildings occupied by the operators and their families. The flood followed down San Francisquito Creek 9 miles from the dam and then down the Santa Clara River 43.5 miles to the ocean. The velocity of the wave and the time required to reach the peak are data of great engineering interest. The following is a summary of these data now available to your commission:

Table of velocities of flood as noted at various locations downstream from the dam. Dam failure assumed at 11.58 p.m.

Location	Time of arrival of flood	Time of travel from preceding location	Distance in miles from preceding location	Velocity in miles per hour
Borel Power Line at Dam	11.58 p.m.	---	---	---
City Power Plant No. 2	12.03 a.m.	5 min.	1.5	18
So. Cal. Edison Co. Sub-Station near Saugus	12.38 a.m.	35 min.	7.5	12.9
So. Cal. Edison Co. Construction Camp at Kemp	1.20 a.m.	42 min.	7.5	10.7
Fillmore Bridge	2.25 a.m.	65 min.	12.7	11.7
Santa Paula	3.10 a.m.	45 min.	8.5	11.3
Saticoy Bridge	4.15 a.m.	65 min.	6.8	6.3
Montalvo Bridge	5.00 a.m.	45 min.	4.0	5.3

It seems probable that the flood peak immediately below the dam exceeded half a million second-feet and this, together with its occurrence in the darkness, and the suddenness and violence of the wave, was such that very few of the persons in the constricted valley below the dam escaped with their lives, though they were immediately adjacent to the safety of the steep slopes of the bordering hills. Even at a construction camp of the Southern California Edison Company, 16.5 miles below the dam, more than 80 out of about 140 perished.

The damage caused in the path of the waters 52 miles to the sea was very great. The record of known dead at this time is 235 and 200 are still missing. Fortunately no trains happened to be passing over

the railroad track inundated, and but few automobiles were on the many miles of highways destroyed. The total property loss of farms, orchards, small towns and public utilities will certainly be many millions of dollars.

METHODS FOLLOWED IN CONSTRUCTING THE DAM

The Los Angeles Bureau of Water Works and Supply placed at the commission's disposal a complete set of construction plans and photographs of the St. Francis Dam. By means of these, and by discussion of construction methods with Mr. Wm. Mulholland and several of his assistants, the essential construction data were ascertained.

The first step was the construction of a concrete wall 8 feet thick (narrowed to 5 feet at the top) and about 80 feet long at the bottom and 155 feet at the top, placed in a trench carried down into tight material under the stream bed to an elevation of approximately 1638. The foundation of the dam was then excavated behind the wall to elevation 1630 across the deepest part of the channel. It will be noted from these elevations that the foundation excavation of the dam was carried 8 feet below the bottom of the wall. The wall was built merely to cut off underflow through the gravel, and small freshets that might come from the San Francisquito drainage during the early construction stages, and convey these waters through a flume past the dam site. Behind this wall the lowest part of the dam foundation was excavated in the dry, and the wall itself finally incorporated into the upstream face of the structure.

The east wing of the dam was notched into the rock of the canyon wall and carried up the natural inclined plane of the rock in the abutment, without steps, and with no cut-off wall. Under portions of the west abutment and about 25 feet from the upstream face, a cut-off trench about 3 feet wide and 3 feet deep, probably with rounding bottom, was excavated longitudinally as deep as it could be carried by use of picks, and finished by prying out rock with gads. The nature of this trench can be observed by inspection of concrete surfaces on one large fragment from the west end of the dam that was carried downstream and now lies upturned showing the original contact with the abutment.

Relief of uplift that might be caused by water pressure underneath the dam was provided for only in the center, or the portion crossing the main channel. On a line about 30 feet in from the face of the dam, 3 holes were bored in line at intervals of 20 feet, while along a second line approximately 15 feet further downstream from the first line there were 7 more holes also at intervals of about 20 feet. The depth of these holes is variously reported to have been from 15 to 30 feet. A small section of pipe with collar was fitted into the top of each hole and cross connections were carried from these pipes to a center outlet pipe which was led out to the lower face near the lowest main outlet pipe. The amount of water draining from this system is understood to have been very small, and was carried down to the caretaker's house, where it was used for domestic supply, lawn watering, etc. Most of this drainage system is included under the portion of the dam which remains standing; this is probably merely a coincidence.

Construction views show that a relatively small cut-off trench was carried along the upper side of the wing wall extending westerly along the ridge from the west abutment of the dam. This trench was largely excavated by a steam shovel.

The concrete aggregate was pit-run sand and gravel taken from the stream bed between one-quarter and one-half mile below the dam, where aggregate used in

construction of the aqueduct and the San Francisco Creek power houses had been secured. The material was neither washed nor graded, but rocks in excess of 6 inches were excluded. It is stated that 1.12 barrels of Portland cement were used per cubic yard of concrete. Specimens deemed typical were taken and tested. These show a satisfactory quality of concrete.

No inspection gallery was carried through the dam, nor was any pressure grouting attempted under any part of the structure. Geological conditions not only at the dam site itself, but for a short distance above and for a considerable distance below, were clearly disclosed by the scouring that took place during the discharge of water from the reservoir.

GEOLOGICAL CONDITIONS AT THE DAM SITE

General Relations—The geological conditions in the vicinity of the St. Francis Dam are both simple and obvious. San Francisco Canyon here has a course of south 60 degrees west. The bottom of the canyon and the steep slopes southeast of the stream-way are carved from a fairly uniform mica schist. The gentler, less regular slope on the northwest side of the canyon is underlain by a reddish conglomerate, in rather ill-defined beds of great but undetermined total thickness. The contact between the two rocks is a fault which, at the dam site, has a strike that is approximately parallel with the course of the canyon and outcrops a short distance above the stream-way, on its northwest side. The dam consequently was placed astride of the fault, the southwest abutment and the foundation of the middle section being schist and the northwest abutment being conglomerate.

The fault is plainly visible as a sharp line that separates the lighter colored schist below from the darker conglomerate of the upper slope.

Mica Schist—The mica schist is an ordinary variety of this fairly common crystalline metamorphic rock. It consists chiefly of quartz, white mica and probably some feldspar. The schistose structure, due to the generally parallel orientation of the constituent minerals, particularly of the mica scales, is very well developed so that the rock has pronounced fissility or cleavage and splits readily into thin plates. As a consequence of this fissility also, the rock weathers and disintegrates into small flakes or scales.

In many places the schist has been strongly sheared, commonly along planes that are roughly parallel with the schistosity or planes of lamination. Along these shear-zones the rock has been changed to an exceedingly fragile flaky material that can be readily excavated with the pick. From a structural point of view such sheared schist is extremely weak material.

The general strike of the schistosity is from north 60 degrees to north 70 degrees east, or about parallel with the course of the canyon at the dam site. The dip is northwesterly. Consequently the lamination of the schist is not far from parallelism with the steep slope of the southeast side of the canyon. This slope, in fact, is conditioned in large part by the laminated structure of the schist. This same structure also is responsible in part for the landslides that have taken place since the dam failed.

The geological age of the schist is not definitely known. The rock, however, is probably at least pre-Cretaceous and may be pre-Cambrian.

The schist is not a soluble rock, nor is it ordinarily softened by wetting. It is capable of withstanding considerable pressure applied in directions approximately normal to its planes of lamination, but is very weak with respect to stresses applied in directions parallel with or at small angles with those planes.

Under such stresses the schist would slip like a pack of cards thrown upon a table.

Conglomerate—The conglomerate near the dam site strikes north 15 degrees west and dips 46 degrees west. It is composed chiefly of detritus derived from the schist terrane and from granitic masses that are not exposed in the vicinity of the dam. The pebbles, usually rather small and sparsely distributed, are embedded in a relatively large proportion of fine-grained, sandy, micaceous, flaky detritus derived from schist and granite. High above the dam site on the northwest slope of the canyon, can be seen rounded outcrops of the conglomerate that appear to be fairly well cemented and moderately resistant to erosion. At the dam, however, the rock has an entirely different character. As its peculiar properties at this place are at least in part a consequence of the faulting, previously referred to, they will be more fully described in connection with that feature.

The exact age of the conglomerate has not been determined, but it is Tertiary and probably Miocene (Mint Canyon formation) or Oligocene (Sespe formation).

San Francisco Fault—The fault which passes beneath the northwestern part of the dam site has long been known and is represented as a "dead" fault on the Fault Map of California compiled under the auspices of the Seismological Society of America. The present investigation shows that there has been no movement on this fault since the dam was built.

At the dam site, the strike of the fault is about north 51 degrees east, or approximately parallel with the course of the canyon. The dip, although variable, is generally between 30 and 45 degrees, to the northwest. At the dam site, a satisfactory exposure of the hanging wall of the slip gave a dip of 40 degrees. The same exposure showed striae that pitch 65 degrees to the northeast, indicative of a slip of which the vertical component.

Along the fault, next to the schist footwall, is a well-defined, dark, gray, clay gouge, which in places is at least 8 inches wide or thick. This material is chiefly comminuted or triturated schist—ground to clay by movement on the fault. When dry, the gouge is fairly hard, but when wet it is an unctuous, plastic, clay, with some enclosed fragments of schist. Under the gouge, in some places for a width of 10 feet, the schist is crushed and sheared. On the upper, or hanging wall side of the main slip-plane, is a reddish gouge, composed of ground-up conglomerate. This gouge is generally thicker than the gray gouge and grades rather indefinitely into disturbed, crushed conglomerate. When dry, this material is firm and coherent, but becomes soft and plastic when wet. In places, this reddish gouge is fully 4 feet thick.

Above the foregoing material, as the slope is ascended, and extending all the way up the northwestern abutment to the top of the dam, the conglomerate is traversed in various directions by intersecting fractures, some of which contain small seams of clay gouge, and others are filled with gypsum. The pebbles in the conglomerate have, in many instances, been fractured, sheared and faulted. Finally, the whole mass of the conglomerate has been so minutely crushed as to have lost most of the strength to be expected in a rock possessing its general appearance. When dry, the rock is moderately hard and fragments of considerable size can be broken out and trimmed down with a hammer to specimen size. When, however, a piece of the rock is placed in water, a startling change takes place. Absorption proceeds rapidly, air bubbles are given off, flakes and particles begin to fall from the sides of the immersed piece, the water becomes turbid with suspended clay and,

usually in from 15 minutes to an hour, a piece the size of an orange has disintegrated into a deposit of loose sand and small fragments, covered by muddy water. Whatever may have been the original cementing material of the conglomerate, its efficiency has been destroyed by crushing, aided possibly by solution, and the rock at present is held together merely by films of clay. It is possible that this part of the conglomerate, as originally deposited, contained considerable clay that never became lithified.

This remarkable characteristic of the conglomerate is probably local and confined to a belt within some undetermined distance from the fault. The rounded outcrops previously referred to as appearing higher up the slope could scarcely exist if the conglomerate at that distance from the fault were equally susceptible to the disintegrating effect of water.

That the same process of disintegration above described was going on rather extensively where the conglomerate was covered by the water of the reservoir, is clearly shown by the character of the residual material left on the conglomerate where the escaping water has not cleaned off all of the surface material.

Clearly, when thoroughly wet, the conglomerate at the northwestern abutment of the dam ceased to have the characteristics commonly denoted by the term rock.

Whether the movement on the fault was normal or reverse is not known. The fact that the conglomerate is obviously younger than the schist suggests a normal fault, although the rather low dip and the condition of the conglomerate in the hanging wall are indicative of overthrust.

Major Earth Movements—A careful examination of the contact fault in the vicinity of the dam site shows no evidence of recent movement. According to Mr. H. O. Wood, in charge of the Seismological Laboratory of the California Institute of Technology, Pasadena, their seismographs recorded no earth tremors of even slight intensity at any time near the time of the dam failure.

There appears to be no reason to believe that faulting or other major earth movement was to any degree responsible for the failure of the dam.

Landslides—The mica schist which occupies the southeast side of the canyon shows separation planes along the schistosity, and shear surfaces dipping northwesterly at 30 degrees and more. The canyon slopes are steep and approximate the dip of the schistosity and shear surfaces. Landsliding is therefore always imminent and may be produced by any one of several causes.

Above the dam site several marked recent slides have taken place. One, a short distance upstream from the dam, broke the road and carried a large mass of rock and earth down to the floor of the valley. A careful examination of the surface of this slide shows no water lines, erosion furrows, or other evidences of the action of the standing or moving water of the reservoir. Evidently the sliding occurred after the withdrawal of the water from the reservoir. The added weight of the infiltrated water while the reservoir was full, and the rapid removal of the water support when the dam failed are sufficient causes for the landslides above the dam.

At the east abutment of the dam and immediately below the dam site much recent sliding has taken place, and during the visits of the commission to the dam site a continuous rain of rock fragments was coming down the slope, accompanied by clouds of dust. This sliding is evidently due to the removal of support as a result of the destruction of the dam and the undercutting of the slope by the waters released by the dam failure.

Smaller landslides and slumps are found along the slopes above the wing wall. These clearly followed the withdrawal of the water from the reservoir and were due to the removal of support from the water-soaked and softened outer portions of the conglomerate.

It is concluded that all of the recent landslides in the vicinity of the dam site took place after and as a result of the failure of the dam and were in no way responsible for such failure.

CONDITIONS AT THE DAM AFTER FAILURE

The wrecked westerly part of the dam from a point 70 feet west of the standing section to the end of the wing wall, as well as the wing wall that still remains, was founded on the conglomerate. Eastward from the base of the conglomerate across the stream bed and up the east side of the canyon the structure rested on schist. The contact between the conglomerate and schist is along a fault plane that shows considerable ancient movement. Water rushing through the westerly break in the dam has scoured both conglomerate and schist to a considerable depth, the principal part of the scouring taking place toward the toe of the dam, probably due both to the character of the material at this particular location and to the fact that a ridge just upstream from and practically parallel to the face of the dam acted as a submerged weir over which the water poured onto the downstream part of the foundation. To the westward of the standing section and against its base a narrow channel was cut through the schist to a depth well below all of the concrete in the structure, with the exception of the concrete coffer dam sections at the upstream face and a thin section carrying the steps on the downstream face. It is therefore possible to observe the character of the material which underlaid that part of the dam.

To the eastward of the standing section the water carried away a large amount of the schist not only on the side of the canyon or along the abutment, but in the bottom. Probably due to combined effect of water soaking and undercutting, a very large and conspicuous slide has developed on the hillside on approximately the line of the eastern abutment. Material was still cascading down the face of this slide 10 days after the failure, and from observation in the field it is apparent that the slide movement will continue for some time.

The distance to which large masses of concrete from the dam have been transported is probably one of the most impressive phenomena of the disaster. All of the fragments from the westerly side of the dam have been carried some distance downstream. Many of the large fragments from the easterly side have moved only a short distance out of place and now rest against the base of the standing section, but several very large masses of concrete from this side have been carried downstream as far as the large masses from the westerly end, being recognizable from the inclusions of schist upon which they rested. One large mass from the west side is turned bottom up and the foundation material adhering to it shows that it came from the part of the dam directly over the contact between the conglomerate and the schist.

Discharge of water from the foundations and from seeps along construction joints in the concrete of the standing section and in the masses washed downstream was very noticeable immediately after the break, when the site was inspected informally by several members of the commission, but had markedly decreased during the few days that intervened before the commission assembled and during the time that its investigations were under way. The most notice-

able discharge was from the seams in the conglomerate about on a line between the standing section of the dam and the broken end of the wing wall, and about two-thirds of the way up the abutment from the bottom. Very noticeable seeps occurred along the top of the gouge between the schist and the conglomerate.

A short length of the two-inch pipe that formed part of the drainage system along the second line of holes drilled under the dam is now protruding from the large slab of concrete that has broken away from the easterly end of the standing section. That is the only part of the drainage system that can now be identified.

The rapid lowering of the water in the reservoir caused several large landslides that are very conspicuous as shown in pictures looking upstream from the dam site. The most important of these is on the easterly side of the reservoir a short distance upstream from the dam, where displacement of a road shows vertical movement of approximately forty to fifty feet along the junction of surface earth and material that is probably very similar to that against which the east abutment of the dam rested.

Seepage from the water-soaked slopes of the reservoir basin has contributed a considerable but constantly decreasing stream ever since the break, and four days after the disaster amounted to 15 second-feet.

Triangulation between stations established during construction and the tying in of one fixed point that has moved S. 2° 52' W. 0.70 feet. The course of the radius at this point was N. 51° 22' E. It is yet uncertain whether this movement is due to tilting, to horizontal displacement of the whole mass, or to a combination of the two. The surface of the conglomerate on the westerly abutment, shortly after the break, showed marked softening due to water soaking. After a few days drying this material showed clean smooth surface when broken, and some of the hardest specimens rang under the hammer. Many of these, however, go to pieces when immersed in water for a few hours, and samples taken over a considerable area have gone to pieces almost immediately upon immersion. Material from the gouge along the fault between the conglomerate and schist rapidly becomes soft and unctuous when immersed. An attempt was made to prepare two samples of the conglomerate for compression and absorption tests. One broke in preparation, and the other stood only 523 pounds per square inch in compression when dry. See reports from the testing laboratory included as Appendices.

CAUSES OF THE FAILURE

The St. Francis Dam was designed with a gravity section and was arched in plan. Experience has shown that this type of structure is preeminently safe and it is generally accepted by engineers all over the world as a conservative design.

The material in the dam is demonstrated by inspection, by tests, and finally by the behavior of enormous blocks remaining from the wreck, to have been of satisfactory quality and adequate strength. Tests of samples cut from typical blocks showed an average crushing strength of about 2400 pounds per square inch, which is much beyond any stresses to which it could have been subjected under normal conditions.

There were no contraction joints built in the dam, which is the case in many existing dams, and, in any event, the failure can not be attributed to their absence.

There can be no question but that such a dam properly built upon a firm and unyielding foundation would be safe and permanent under all conceivable

conditions, except perhaps faulting and earthquake shocks of tremendous violence. Indeed such a dam may properly be deemed to be among the most durable of all man-made structures. Unfortunately in this case the foundation under the entire dam left very much to be desired. The material under the central and left, or easterly, end was a mica schist of thin and easily separable laminae. The west end was founded upon a reddish conglomerate which, even when dry, was of decidedly inferior strength and which, when wet became so soft that most of it lost almost all rock characteristics. Numerous samples taken from the present surface which has been eroded to a considerable depth below the original foundation and some samples from underneath the remaining west wing wall, quickly softened and changed into either a mushy or granular mass when immersed in water. Unfortunately this material is of such a nature that when entirely dry it is hard and rock-like in appearance and characteristics, although defective in compressive strength. Of two samples taken from the firmest part of the eroded foundation, one broke in preparation for testing and the other, cut into a 5.77-inch cylinder 7.12 inches long, showed a compressive strength of only 523 pounds per square inch, or between one-fourth and one-fifth that of the concrete in the dam. Greater strength might have been shown had the sample not been moistened by exposure at the time of the dam failure, but on the other hand it would have been much weaker with a larger moisture content.

With such a formation, the ultimate failure of this dam was inevitable, unless water could have been kept from reaching the foundation. Inspection galleries, pressure grouting, drainage wells and deep cut-off walls are commonly used to prevent or remove percolation, but it is improbable that any or all of these devices would have been adequately effective, though they would have ameliorated the conditions and postponed the final failure.

While as yet the manner and chronological order in which the failure of various sections of the structure occurred are not entirely certain, the present locations of the fragments from the west end indicate this as the point of initial failure which was quickly followed by progressive but rapid failure of the east end. Many of the available data indicate that the initial foundation failure occurred near or at the old fault or contact between the conglomerate and schist under the west end, and was due to the percolation of water into and through this section of the foundation, with resulting softening of the conglomerate under the dam. Either a blowout under, or a settling of the concrete at this place, or both, occurred, quickly followed by the collapse of large sections of the dam.

It is probable that the rush of water released by failure of the west end caused a heavy scour against the easterly canyon wall at the toe of the dam. This rapidly cut away the schist including the material under the toe of the east part of the dam and caused the failure of that part of the structure. The escaping water then continued to cut away the schist from the east wall of the canyon until a maximum depth of about 30 feet below the original foundation level was reached.

A fact which should be very reassuring as to the stability of a gravity dam on reasonably sound bedrock is that although the central section still standing must have been exposed to tremendous and sudden stresses amounting to shocks, while still subject to practically full water pressure, it is undisturbed except from an apparent movement at the top of some 5.5 inches downstream and 6 inches toward the easterly abutment.

The record made by the Stevens gage which was located on the standing middle section of the dam is shown. Using this record in connection with the known areas and capacities of the reservoir at varying water elevations, the following table has been made:

Discharge from St. Francis Reservoir, deduced from copy of chart from automatic water stage register located on top of the portion of the dam that remains in place. The absolute time is obviously in error.

From	To	Drop in water surface, feet	Discharge, C.F.S.
2 p.m. March 12, 1928	12 midnight March 13, 1928	0.93	22
12 midnight	12-06 a.m.	.61	740
12-06A	12-14A	.64	2,200
12-14A	12-20A	.65	3,650
12-20A	12-24A	.65	5,520
12-24A	12-26.7A	.65	8,160
12-26.7A	12-29A	.65	9,600
12-29A	12-30.5A	.65	11,700
12-30.5A	12-31.5A	.65	22,000
12-31.5A	12-32.2A	.65	31,500
12-32.2A	12-33.4A	.10	36,700
12-33.4A	12-34.3A	.10	48,900
12-34.3A	12-34.9A	.10	73,300
12-34.9A	12-35.3A	.10	110,000
12-35.3A	12-35.5A	.10	220,000
12-35.5A	12-35.65A	.10	295,000
12-35.65A	12-35.75	.10	438,300

Too much reliance must not be placed upon this, as the horizontal or time scale of the record is very small and the accuracy of the clock movement is not certain. However, for at least many hours before the record ends there clearly were not water surface fluctuations except a lowering beginning about 2 p.m., which was so slight that it might have been due to upstream wind movement.

This record shows that a water subsidence which could not have been due to upstream winds began about one-half hour before the flow from the reservoir reached enormous proportions, and further, that the curve of emptying is regular up to that point. Such accelerating water lowering, as opposed to an abrupt fall, is apparently contradictory to many data reported as to suddenness of the downstream movement of the flood wave, especially at Power House No. 2, where there appears to have been no such warning as would have been given by a gradually increasing stream flow such as would have resulted from anything like the deduced record given in the table.

In so far, however, as the validity of this record is accepted, the discharge of the impounded waters was something like that given in the table.

CONCLUSIONS

1. The failure of St. Francis Dam was due to defective foundations.

2. There is nothing in the failure of the St. Francis Dam to indicate that the accepted theory of gravity dam design is in error or that there is any question about the safety of concrete dams designed in accordance with that theory when built upon even ordinarily sound bedrock. On the contrary, the action of the middle section which remains standing even under such adverse conditions is most convincing evidence of the stability of such structures when built upon firm and durable bedrock.

3. The failure of this dam indicates the desirability of having all such structures erected and maintained under the supervision and control of state authorities. Water storage, with its necessary concomitant dams and embankments, is peculiarly essential to the development of California resources, and in the great majority of cases failures would result in serious loss of life and property. This disaster emphasizes the

fact that while the benefits accrue to the builders of such projects, the failures bring disaster to others who have no control over the design, construction and maintenance of the works. The police power of the state certainly ought to be extended to cover all structures impounding any considerable quantities of water.

Respectfully submitted.

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Consulting engineer.

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F. E. BONNER, San Francisco, California.
District Engineer, U. S. Forest Service and California Representative Federal Power Commission.

H. T. CORY, Los Angeles, California.
Consulting engineer.

F. H. FOWLER, San Francisco, California.
Consulting engineer.

March 23, 1928

REPORT OF COMPRESSION TEST OF ROCK

Test made for: Commission appointed by Governor Young to investigate failure of St. Francis Dam.

Description of specimen: Cylindrical core, 5.77 inches diameter, 7.12 inches high, cut from sample selected by the Commission at the dam site; core was cut by L. A. County Road Department in presence of Mr. Perkins and a representative of the laboratory. No water used in coring this specimen.

LABORATORY DATA

Test number, 17857.
Specimen mark, R.B.
Weight, total lbs., 15.31.
Weight, per cu. ft., lbs., 150.60.
Specific gravity, 2.414.
Average diameter, in., 5.77.
Average height, in., 7.12.
Area, sq. in., 26.14.
Compressive strength—
Total lbs., 11,570.
Lbs. per sq. in., 557.
Corrected to standard specimen—
Lbs. per sq. in., 523.

REMARKS—Height divided by diameter is 1.23, correction made by multiplying crushing strength by 0.94 (according to American Society for Testing Materials) Standard method for securing specimens of hardened concrete from the structure, Serial Designation C42-27; Character of fracture conical.

After coring, specimen was given three coats of shellac to prevent absorption of water during test for specific gravity. The smaller specimen of stone submitted, fractured during the coring process. A test for rate of absorption was made on a portion of this specimen and the following results were obtained:

Total time elapsed	Per cent absorption by weight
10 minutes	0.59%
20 minutes	.87%
30 minutes	.69%
40 minutes	.71%
50 minutes	.73%
1 hour	.73%
1 hour 10 minutes	.75%
1 hour 20 minutes	.75%
1 hour 30 minutes	.77%
1 hour 40 minutes	.77%
1 hour 50 minutes	.79%
2 hours	.79%
2 hours 20 minutes	.79%
Total porosity	2.35%

In making the above test, the rock was broken up into pieces passing a 1½-inch ring, and placed in a bottle of water; each piece was carefully brushed to

remove loose particles; the total sample weighed 503.6 grams dry. At the end of 20 minutes the samples had disintegrated in a very marked way, and a layer of sand about three-eighths of an inch deep was formed on the bottom of the bottle.

The absorption was measured by adding small amounts of water to keep the total volume constant, and the total porosity was obtained by evacuating the sample in the bottle.

Respectfully submitted.

RAYMOND G. OSBORNE LABORATORIES.

By S. S. STAHL, (Signed).

March 23, 1928

REPORT OF COMPRESSION TESTS OF CONCRETE.

Tests made for: Commission appointed by Governor Young to investigate failure of St. Francis Dam.

Description of specimens: Cylindrical cores approximately six inches dia. cut from blocks of concrete selected by Commission at dam site; cores were cut by L. A. County Road Department, in presence of Mr. Perkins, and a representative of the laboratory.

LABORATORY DATA

Test number	17854	17855	17856
Specimen mark	1	3	4
Age	About 2 years	2 years	2 years
Weight, total lbs.	23.23	27.58	25.45
Weight, per cu. ft., lbs.	137.4	142.8	141.7
Specific gravity	2.202	2.289	2.271
Average diameter, in.	5.89	5.85	5.85
Average height, in.	11.50	12.50	11.75
Area, sq. in.	27.25	26.88	26.88
Compressive strength—			
Total lbs.	49,810	53,940	73,020
Lbs. per sq. in.	2,562	2,007	2,717

CHARACTER OF FRACTURES—

Specimens 1 and 3 failed in planes nearly parallel to the axis of the specimen. No. 4 showed a partly conical fracture; Specimen No. 3 contained a spherical piece of soft conglomerate (?) about 2½ inches in diameter and one large piece of laminated stone probably mica schist. Specimen No. 2 broke off which revealed a large laminated stone, which rendered the core unfit for testing. The specific gravity of this stone was 2.705.

REMARKS:

To expedite completion of tests, specimens were all tested as received, that is, air dry except for some water absorbed during the curing process.

Tested in Olsen Universal Testing machine; speed of moving head—.05 inches per minute.

Tests witnessed by Messrs. Wiley, Bonner, Hyatt, and Perkins.

Respectfully submitted.

RAYMOND G. OSBORNE LABORATORIES.

By (Signed) S. S. STAHL.

Community Thanks

District Engineer

Calaveras County Snow Frolic held at Big Trees on January 15th was well attended. The road was opened by the Division of Highways in order to make it possible. The following resolution was passed by the Angels Boosters Club on January 17th.

"Be It Resolved, That Mr. R. E. Pierce be conveyed a vote of appreciation and thanks for his whole-hearted cooperation and generous services rendered us in making the second Booster Snow Frolic the success that it was.

Grandma—"Oh Jenny, darling, I am surprised! Aren't you going to give your brother part of your apple?"

Jenny—"No, Grannie. Eve did that and she's been criticised ever since."

SOLVING SAN FRANCISCO'S ROAD PROBLEMS

(Continued from page 9.)

Hill, and at Castro Hill near Hayward have been completed and rock placed on a one-mile section at the Hayward end, thus completing all heavy grading on the present road and leaving most of the incompleting heavy grading on line changes where it can be done without interfering with traffic and allow of completion of the three large bridges. The road is open to eastbound traffic and cutting of points and making of side fills can progress until the weather breaks for spring, when the second part of the program will be taken up to allow of opening up of the new road to the heavy summer tourist traffic.

RECONSTRUCTING ROAD

As the traffic increases between the East Bay cities of Oakland, Alameda and Berkeley and the city of San Jose and southerly points, it is becoming increasingly apparent that this highway on the east side of San Francisco Bay is inadequate. This route is being reconstructed where traffic and disintegrated pavement conditions require. The portion from Milpitas to San Jose, having been completed in 1926, the 4.38-mile section between Warm Springs to Milpitas is now under contract to the Allied Contractors, Inc. and is nearly complete. The 11-foot concrete shoulder widening on one side is complete and the 18-foot asphaltic surface will be complete early in March and it is expected that by the middle of March the entire project will be open to traffic.

NEW METHOD USED

A new method of spreading asphalt mixture was used on the latter half of this job. An Ord mechanical surfacer specially built with forward screed for primary leveling, intermediate set of narrow teeth for raking and a rear screed for smoothing, was used instead of hand rakes in preparing for the roller. A very satisfactory smooth surface is being obtained which would indicate a successful future for mechanical finishers in asphaltic work.

Writes Up California Highways

The Cornell Civil Engineer of January, 1928, contains a very interesting article on the California state highway system. The article was written by Wm. F. Faustman of the engineering department of the Division of Highways, and a graduate of Cornell with the class of 1907. The article gives a very clear account of the California highway organization.

Traffic Recommendations of Supervisors

THE following report and recommendation was unanimously adopted by the County Supervisors Association of the State of California, held in the city and county of San Francisco on March 7, 1928.

Your committee of engineers appointed in October, 1927, to report to you upon truck weights and regulations, herewith present their report.

The committee consists of R. M. Morton, former State Highway Engineer, Chairman; E. E. East, Chief Engineer of the Automobile Club of Southern California; C. C. Cottrell, Manager, Highways Bureau, California State Automobile Association; Harry H. Hume, County Road Engineer, Butte County; Lloyd Bowman, County Surveyor, Santa Cruz County; Chris P. Jensen, County Surveyor, Fresno County; and George W. Jones, Road Commissioner, Los Angeles County.

In addition to continuous individual study of the various subjects, the work of the committee has included several sessions held at San Francisco, Los Angeles and Fresno, at which various interested firms and individuals presented arguments relating to the various phases of the subject.

TESTS

The subject assigned to the committee could very properly be investigated in great detail. The matter of static weights and increase due to driving torque, impact on road surfaces and bridges, stresses in pave-

ment slabs of various designs and thicknesses, merit thorough research study to determine conclusively, from an engineering viewpoint, the accurate answers to the questions of greatest interest in the minds of the supervisors. The opportunity for such tests obviously was not afforded to this committee, either in time or in funds. Such tests, to be of value, should be carefully conducted by research specialists.

Without the benefit of authentic tests conducted under California conditions, the committee has been compelled to proceed according to results of such tests as are available which have been conducted elsewhere, and in accordance with engineering principles, plus a measure of common sense.

With a testing organization such as we have in mind functioning with proper facilities and financial support from the motor vehicle license receipts, decisions of expediency and special interest influence in legislation would pass into the discard, and our future motor vehicle legislation could be based upon sound economic and engineering principles.

Recommendation—A properly equipped research testing laboratory be authorized and financed under the direction of the proper state agency, to acquire engineering data pertaining to the operation and effect of vehicles on highways.

ENFORCEMENT

It is the opinion of your committee that regulations are of little or no value unless properly enforced.

(Continued on next page.)

COMMUNICATIONS

Urges Importance of Ocean-to-Ocean Roads

Los Angeles, Cal.,
March 1, 1927.

EDITOR CALIFORNIA HIGHWAYS AND PUBLIC WORKS:

Strange to say we daily hear of highway construction, the progress and the great necessity, also the vital advantages, yet we hear nothing of the most important and vital link in it, meaning a national ocean-to-ocean highway. Strangely, the auto clubs, State Highway Commission, public officials and authorities and all official organs of the aforesaid are silent on this topic.

Today we have the spectacle of the richest, greatest nation on earth, with its citizens ploughing their way through hundreds of miles of unpaved roads, or poorly paved, to the destruction of auto, the nerve system and the spinal column, whilst thousands of people are out of employment. We with the vastest supply of men, material and money, have no National Highway, where we should have two, one north, one south; great paved roadways, say fifty feet wide at least, for pleasure, business, preparedness. Why such inefficiency, why such false economy, why such inexcusable lack of ordinary business sense?

Is it possible that ulterior motivated influence holds

off this vital improvement; is it the same selfish, jealous crew that for decades held back the Panama Canal, that has aborted a great system of internal canals, that allowed the Mississippi Valley to fall victim to a world catastrophe, namely the national railroad interests, which do not, but should belong to the people, and thus prevented from casting monkey wrenches into needed public enterprises? Private monopoly all too often strangles and smothers public improvements until they can dominate them for their own exploitation. Is railroad influence smothering national highways?

It is the bounden duty of all public officials, auto clubs and the press to hammer on ocean-to-ocean highways until we get them.

Anything less is plain treason to a public duty; there exists no excuse for delay; the present situation is a disgrace and a menace to the nation.



C. H. V. LEWIS.

CHARLES H. V. LEWIS,
Senator, Thirty-eighth District.

TRAFFIC RECOMMENDATIONS OF SUPERVISORS

(Continued from page 32.)

By far the great majority of the commercial users of highways have a desire to comply with all regulations which are put into effect. There is, however, another group who endeavor by every device and trick of the trade to evade traffic regulations and requirements. It is for this minority that enforcement machinery must be set up, and it is for them that there must be certainty of punishment, if it is to be effective.

Consideration of truck weights and regulations immediately points to the necessity for uniform enforcement. The system of enforcement at present employed in this state is not as satisfactory as is needed, in that there is a lack of uniformity between the various counties and between the counties and the cities. Both truck operators and motorists alike become familiar with the different importance placed upon certain infractions in various communities, and there is a tendency toward a general disregard of the restrictions which we now have. It is useless to add to or modify the restrictions of the Motor Vehicle Act without placing the enforcement machinery in full repair. It appears to us highly desirable that regulations should be uniform throughout the state. Trucks can travel up to 300 miles in a single day. In so doing they pass through many different communities. Under present conditions it is impossible, without full control being vested in some central administrative head, for enforcement to be uniform.

The disadvantages of the present dual control are well known. The officers are usually local residents, and inasmuch as they are paid out of funds which would otherwise come to the county, they are really paid by the county, although the funds are actually handled by the Motor Vehicle Division. The local governing bodies influence the officers, for under the present system they can reduce or increase the number of officers as they see fit. This influence is not always in harmony with the policies of the Motor Vehicle Division and such a situation is demoralizing to the personnel.

Officers can not be readily transferred from one locality to another under the present system, thus preventing the Motor Vehicle Division from distributing the forces throughout the state to the best advantage.

The existing discretionary right of the courts in the matter of fixing fines constitutes an encouragement for influential violators to use every means possible of evading the penalties. Such evasions make impossible a uniform law enforcement, if for no other reason than the discouraging influence upon the traffic officers themselves.

We see no reason why minimum penalties should not be specified, of a sufficient amount to constitute a deterrent.

Some motor vehicle operators consider that it is a distinct financial gain to themselves to evade some of the present regulations, and repeatedly pay the fines that might be imposed upon them under the present provisions of the Motor Vehicle Act.

Your committee has discussed different methods by which the existing dual control might be eliminated, and are insistent that adequate enforcement is the most vital modification needed. However, it is outside our province to specify and recommend to your honorable body the exact manner by which improvement of present methods should be accomplished.

Recommendation—(a) That a manner of uni-

form enforcement of the provisions of the Motor Vehicle Act be put into effect which will secure a greater degree of compliance with these provisions.

(b) That minimum penalties be specified, of a sufficient amount to constitute a deterrent.

FOUR-WHEEL TRUCKS

Your committee has no quarrel with the present weights permitted on motor vehicles. The maximum gross load of 22,000 pounds on a 4-wheel motor vehicle as it now stands in the law appears to us reasonable from every viewpoint. It has been agreed upon as a result of modifications in legislation over the past six years. We do not find the commercial haulers dissatisfied with it, and we are unable to agree with the view that this weight is destructive to improved roads.

Truck hauling is an essential part of our economic life. The delivering of commodities from factory or farm to their market, with the speed and convenience afforded by trucks, results in a saving reflected to every individual in the state. The highways and the trucks are the logical extension and supplement of the railroad lines. To bar reasonably loaded trucks from our highways would seriously impair the existing economic structure to a greater extent than the small benefit which would accrue from preventing some road damage.

We incline to the view that the building of highways, for whatever purpose, entails upon the public the duty of expending sufficient money to insure improvements of practical value, under reasonable restrictions, for all reasonable types of transportation.

A reasonable attitude towards economical transportation requires that a reasonable load be permitted. A 22,000-pound load permits the hauling of 5 to 6 tons on the average 5-ton truck, which net load is in accordance with the manufacturer's rated capacity. To disturb this figure would have far reaching and disastrous effects on the truck industry as well as on our economic structure.

Recommendation—That the maximum gross load to be permitted on a motor vehicle having four wheels shall be maintained at 22,000 pounds.

SIX-WHEEL TRUCKS

It has been established through tests conducted by disinterested agencies that with the same load, the placing of additional sets of wheels under a 4-wheel motor vehicle lessens the wheel pressure on the road and the impact on the road surface. It is therefore logical that this reduction should permit an increase in the load. No increased menace to road improvements is presented except to bridges, with an increase of 12,000 pounds in the total load, and assuming that the original 4-wheel vehicle weighs 22,000 pounds gross.

We realize the menace which this increased load presents to the older and more obsolete bridges, but the improvement of our highway surfaces has advanced farther than the modernizing of our bridges. They constitute extremely important links in our system of communication, and we can not postpone a policy of bringing obsolete bridges to a condition equally strong as our road surfaces. We believe it to be the duty of public officials to arrange for repairing or rebuilding weak bridges in accordance with the modern standards required by modern traffic. The greater transportation economics resulting from a larger load on 6-wheel motor vehicles justify this increased outlay of public funds.

Recommendation—That the maximum gross load to be permitted on a motor vehicle having six or more wheels, or on any other vehicle, shall be 34,000 pounds.

SIX-WHEEL TRUCK DEFINED

Since the Motor Vehicle Act was amended in 1923 to permit a gross load on 6-wheel vehicles of 34,000 pounds, it has been demonstrated that a definition is needed of what is to constitute a 6-wheel vehicle. Due to the lack of suitable definition, a considerable industry has sprung up for the placing of additional axles under trucks originally built with two axles. You are all familiar with some phase of this situation and have seen the various devices masquerading under the guise of an additional axle, by means of which the addition of 12,000 pounds of load is justified under our present law. The obvious intent of the legislature in permitting a 6-wheel vehicle to carry additional load was that the load should be equally distributed between the major axles at the rear of the motor vehicle, for it is only in this way that abuse of the additional axle privilege can be prevented.

We have examined many designs submitted to us, and find that there are inherent difficulties which prevent a uniform distribution of the load between the main axle and the attachment. The load on the main axle can not be reduced below a certain amount and taken up on the idler, because of loss of traction. A large proportion of the weight of the rear of the truck must be on the traction wheels. Therefore, all of the 6-wheel attachments provide for the distribution to the additional axle of only the minor portion of the load.

Some of the devices in use are so complicated that the inertia of the movable parts in passing over an obstruction would prevent the additional axle from taking the load for which it was designed. Others are in daily use which permit the additional axle to be drawn up and held free from the ground at the will of the operator, so that all the load will be on the traction wheels.

That abuses such as these should be countenanced is inconceivable. Before these industries grow to larger proportions, a specific definition of a 6-wheel truck should be written into the law. The only proper definition is one which will compel an equal distribution of the load on all four rear wheels, to be accompanied by equal driving capacity through both rear axles.

Recommendation—That on motor vehicles permitted to carry a maximum gross load of 34,000 pounds, additional axles shall be spaced not closer than 42 inches to the adjacent axle. The maximum axle load for such vehicles shall not exceed 14,000 pounds and the maximum wheel load shall not exceed 7,000 pounds.

MULTIPLE AXLE TRAILERS

Another abuse not anticipated when the law was modified in 1923 is created by the manufacturers of trailers. Trailers are constructed and in use on the highways on which loads up to 100,000 pounds can be carried. This is done by the setting of short axles, with a wheel on each end, in the same transverse place across the body of the vehicle. For instance, in the same plane, there are in some cases, as many as three axles and six wheels. Under the present wording of the act, these vehicles can not be considered illegal if the weight, on each wheel does not exceed 9,000 pounds, the weight on each axle 18,000 pounds, if sufficient width of rubber is provided to keep the weight per inch width to 700 pounds or less. However, public highways can not be expected to

carry such unreasonable loads, and they should not be permitted. Prevention of the occasional moving of the loads for which these trailer vehicles are built would not interfere with the economic structure dependent upon truck transportation.

Recommendation—It is our recommendation that motor vehicle or trailer axles placed on transverse planes, which are closer together than 42 inches shall be considered as one axle.

AXLE LOADINGS

From all the evidence produced before our committee, we do not find that the operation of a 4-wheel truck with a gross load of 22,000 pounds requires an axle limit as high as 18,000 pounds. The limitation of axle loading on a 4-wheel truck should be reduced to 16,000 pounds, with 8,000 pounds permitted on each wheel.

Recommendation—That the maximum axle loading on a 4-wheel truck be reduced from 18,000 pounds to 16,000 pounds, and the maximum wheel loading be reduced from 9,000 pounds to 8,000 pounds.

TRAILERS

It is not practicable to apply to trailers the same principles of load distribution that are recommended for application to motor vehicles. We find considerable abuse in the use of trailers.

There are limitations in the design of motor vehicles which compel the manufacturer to allow for a large proportion of the load on the rear. This is done in order to obtain traction, brake action, etc. Trailers with four wheels and two axles should be permitted to carry the same load as 4-wheel motor vehicles. However, just as soon as a trailer becomes a vehicle with six or more wheels, complications arise regarding the distribution of the load between the axles, and the location of the additional axles. Load distribution between the axles of a trailer is impractical to enforce and depends upon how the live load is adjusted. On a motor vehicle, the load distribution is dictated by design limitations.

Recommendation—That the maximum gross trailer load shall not exceed 22,000 pounds, the maximum load on any trailer axle not to exceed 16,000 pounds, and on one wheel 8,000 pounds.

INCREASED SPEED FOR TRUCKS

Under the present law, vehicles on pneumatic tires, weighing less than 18,000 pounds, are permitted the regular touring car speed of 40 miles per hour. Under this section the heavy stages operate.

There is probably no provision of the Motor Vehicle Act which is so largely violated as that which limits the speed of heavily laden trucks on solid tires, and these violations account for most of the damage to highway improvements.

It is well known that the cushioning effect of pneumatic tires minimizes the destructive effect of heavy loads, but on account of greater operation costs the industry should be further encouraged to discard the destructive solids in favor of pneumatics.

The essential element of relief of traffic congestion is to keep the traffic moving at a rapid rate. This is also essential to reduction in transportation costs. It therefore seems desirable to your committee that less drastic speed limitations should be imposed on heavy truck transportation, when handled by equipment less destructive to the highway.

There is a glaring inconsistency in the present act in permitting a gross load less than 18,000 pounds, on pneumatic tires, to travel at touring car speed, and then restricting a load of 18,001 pounds, on the

same tire equipment, to a speed of 20 miles per hour. The benefit to highways and to economic transportation which will accrue from increasing the present speed restrictions, provided braking facilities are adequate, in accordance with another recommendation in this same report, will more than offset any possible disadvantage that we can foresee.

Recommendation—That Section 118 (a) of the Motor Vehicle Act be amended to fix speed of trucks equipped with pneumatic tires as follows:

Trucks, including loads, weighing less than 18,000 pounds, 40 miles per hour; trucks, including loads, weighing 18,000 pounds, and not exceeding 22,000 pounds, 30 miles per hour; trucks, including loads, weighing over 22,000 pounds, 25 miles per hour.

BRAKING STANDARD

A serious defect in our present Motor Vehicle Act is the lack of standards for braking. The present law that the brakes shall be adequate to promptly check the speed of and stop such vehicles does not mean much from an enforcement standpoint. As the permitted speed becomes greater, it is correspondingly necessary that there be a standard of braking, to which all vehicles should conform. This is not a difficult standard to set up and would be of vast assistance to the enforcement officers. Further elaboration of this point is considered unnecessary.

Recommendation—That every motor vehicle or combination of motor vehicle and trailer operating upon the public highways shall be equipped with brakes adequate to bring such motor vehicle or combination of motor vehicle and trailer to a complete stop when tested upon dry asphalt or concrete pavement surface where the grade does not exceed one per cent, and when operating at speeds set down in the following table, in the distance set opposite such speeds, provided that no vehicle shall be tested for brake efficiency at a speed higher than that permitted by law for such vehicle, and further provided that no vehicle be tested for brake efficiency at a speed higher than 30 miles per hour.

Miles per hour	Stopping distance
10	9.3 feet
15	20.8 feet
20	37.0 feet
25	58.0 feet
30	83.3 feet

And provided, further, that any truck, when loaded to capacity, shall have not less than 70 per cent of the gross load under brake control; and any trailer with gross load in excess of 6,000 pounds, when loaded to capacity, shall have not less than 50 per cent of the gross load under brake control.

The above section, however, shall not apply to implements of husbandry, special mobile equipment, or equipment under special permit.

TIRES

The operation of solid tire equipment after its useful life has past is one of the most common abuses on both highway and vehicle. The present Motor Vehicle Act does not adequately cover the situation, but is framed for perfect rubber conditions.

It is the custom of many operators to wear solid tires down to the point where resiliency has passed from the rubber, and this condition often exists even though there is a compliance with the present law as to thickness. Uneven tire surface caused by gouges

and cuts increase the impact and destructive effect of solid tires.

Recommendation—That vehicles equipped with tires of any material other than metal, the weight resting upon the surface of the highway should not exceed 600 pounds upon any inch of the channel base width of tire.

That horse-drawn vehicles equipped with tires of metal, the weight resting upon the surface of the highway should not exceed 500 pounds upon any inch of the width of the tire.

That the minimum thickness of rubber for solid rubber tires should be as follows:

Width of tires, 3 inches to 5 inches, inclusive—1 inch.

Width of tires, 6 inches to eight inches, inclusive— $1\frac{1}{2}$ inches.

Width of tires, 10 inches and over— $1\frac{1}{2}$ inches.

That the variation in the width of the entire traction surface of solid rubber tires due to injury or wear, should not exceed 15 per cent.

That the variation in the thickness of the rubber of solid tires on any part of the entire traction surface, due to injury or uneven wear, should not exceed 15 per cent.

That solid rubber tires should not be permitted to be used on public highways when any portion of the rubber is not securely attached to the channel base.

That dual solid rubber tires should not be permitted to be used on public highways if there is average difference greater than one-eighth inch between the outside diameters of each of the single tires composing the dual tire.

CONCLUSION

Your committee, assembled from various portions of the state, has considered this matter with a sincere desire to be helpful. We believe that in the past insufficient weight has been given the opinions of those competent to know, through training and observation, as to the effect on highways.

It was our decision early in our consideration that it should not be required of your committee to frame in detail the exact wording of recommended legislation, believing that this task can better be performed by a legal committee appointed by your association, with whom we would be glad to cooperate.

Our report represents our own opinions, and not the opinion of any private interest, association or group. We trust that if you can not subscribe to all of our recommendations, at least part of them will prove helpful to you, and if so, we will feel gratified that we have contributed even to a minor extent in effecting a definite adjustment between two seemingly conflicting interests—that is, the public on one hand and the commercial highway user on the other.

In the United States there is a mile of road for every forty persons. Brazil has only a mile to 944 persons. Conversely, every person in the United States has 44 yards of road to walk or ride upon, while the Brazilian must be satisfied with less than 2 yards. We have a mile of road in every square mile and a quarter of area, and Brazil has only a mile in each 10 square miles. Chile has one mile of road to every 150 persons, or each Chilean has the use of 12 yards of road. Chile has a mile of road in each 12 miles of area. Last year Chile spent approximately 48 cents per capita on roads, Peru spent less than 25 cents, Uruguay \$1.09, and Salvador 30 cents, while the United States spent almost \$11 per capita.

Complete Text of Feather Road Routing Report

[EDITOR'S NOTE: A large number of requests have been received for the complete text of the recommendation of B. B. Meek, Director of the State Department of Public Works, in the matter of the location of the Feather River lateral of the state highway system. Below will be found Mr. Meek's report and recommendation to the California Highway Commission together with the formal vote of that body.]

February 15, 1928.

To the California Highway Commission.

GENTLEMEN: Consistent with an allotment made by you for the purpose and at my request, an engineering study of possible routes connecting Quincy, the county seat of Plumas County, with the state highway system at Oroville was begun last August. This study very early developed the fact that a road via the Middle Fork, Feather River Canyon, would be shorter from Oroville to Quincy and from Oroville to the Nevada state line than a road via the North Fork Canyon.

I quote from this first engineer's report:

It has been assumed for purposes of this report that any available route within the Feather River drainage will qualify (legally).

The climate and topography of the country lying between Oroville and Quincy have had a distinct bearing on the matter of the routing of this highway. Always supporting the demand for a river highway in preference to a route over the ridge has been the contention that the river route would be a part of an all-year open road over the Sierras.

Such a possibility actually exists because of the wide separation between the geographic and climatic summits in this region. The geographic summit is at Beckwith Pass at the headwaters of the Middle Fork or at Fredonia Pass at the headwaters of the North Fork. The climatic summit lies along a high western range extending from Red Mountain in the Yuba River territory northwesterly to Mt. Lassen. This range causes heavy precipitation far to the west of the geographic summit with the result of light rain or snowfall in the Sierra Valley or at Beckwith Pass. This heavy precipitation falls as snow on the higher parts of the range at times as great as 36 feet and effectually blocks the roads over the ridge for from five to seven months of the year.

The North Fork cuts through this ridge at a low elevation and heads near Fredonia Pass. This pass is on the Red Bluff-Susanville lateral and is 5700 feet in elevation. The Middle Fork of the Feather River also cuts through this ridge at an elevation below heavy snowfall and heads near Beckwith Pass.

To reach Beckwith Pass by the North Fork Route the road must go over Lee's Summit on Spring Garden Ridge at elevation 4450 lying east of the climatic summit but still having frequent snowfall to the depth of 5 feet or more. No summits within the snow area are crossed via the North Fork to Quincy. Quincy, at elevation 3400, frequently has snowfall to a depth of 4 feet and has had as much as 6 feet.

No intermediate summits are crossed on a route following the Middle Fork leading to Beckwith Pass. To reach Quincy, however, it is necessary to cross the Thompson summit between Nelson Point and Quincy. This summit is the same elevation as Lee's Summit and being but a few miles closer to the climatic summit, has about the same snowfall.

The conclusions from a study of climatic conditions are that no road will be snow free to Quincy or to Beckwith Pass to such an extent that snow removal equipment will not have to be kept in readiness. A road over the ridge via Bucks does not appear practicable as an all-year road. Either of the river roads could be kept open practically every day of the year at a reasonable cost for snow removal. In so far as can be ascertained exceptions to this latter statement might occur with such heavy snowfall as is reported for 1889-90 and 1907.

The profile, page 5 of maps, shows comparative data for the major routes over the Sierras compared with the Feather River Route.

These routes, naming them from south to north, are the Placerville route over Echo Summit, the Victory Highway over Donner Summit and the Yuba Pass Route over Yuba Pass and Beckwith Pass. These routes all have an advantage in distance over the Feather River Route. This advantage, as far as winter travel is concerned, is offset by the high summits to be crossed and the depth of snow.

For purposes of considering the possibility of keeping any of these roads open over the high summits the area covered by snowfall may be divided into two classes: First, that where prompt work with a push plow during or after a storm will clear the roadway with possibly a light rotary to follow and clear the accumulated snow from the shoulders to give the push plow a chance at the next storm. This may be classed as light snow removal where maximum depth rarely exceeds six feet and presents no particular problem in the matter of keeping the road open or any particular hazard to traffic. The other class involves removal where snowfall is much heavier and the depth of packed snow may reach 20 feet or more. This may be classed as heavy snow removal. Keeping roads in areas of the second class open to traffic may be very difficult and requires other equipment and methods than are now employed. Likewise a hazard is presented to traffic in the danger of getting trapped in storms or drifts that may block the road in a very short time.

The difficulties in keeping an open road over high summits depend somewhat on the mileage of light snow removal but more upon the mileage of heavy removal.

To maintain an open road over Echo Summit would involve some 45 miles of light snow removal about 17 miles of which would be in Nevada, and about 10 miles of heavy snow removal. Maintenance of an open road over Donner Summit would require about 30 miles of light snow removal and about 12 miles of heavy snow removal. A road over Yuba Pass would require about 30 miles of light snow removal and 10 of heavy. To keep the Feather River Route open to the state line would require light snow removal for about 75 miles. Only for about 25 miles except in abnormal years would the use of a rotary plow be necessary.

For at least 25 miles of this distance the graders or tractor graders used on regular maintenance would keep the road clear.

To find a justification for the large expenditure that construction of a river route would require, we must find other uses (than local traffic) for this road. Nor need we look far to find them for an extension of this route across Beckwith Pass would encounter less snowfall than any other route. This is due to the fact that the forks of the Feather River cut through the area of heavy snowfall at comparatively low elevations.

There is an unmistakable and growing popular demand for the maintenance of an open all-year road over the Sierras. This demand whether it takes the form of periodical or continuous agitation for keeping open some particular road or pressure for construction of a route that may be kept open with much less difficulty may be taken as evidence of a necessity that means be provided for continuous access to the states lying east of California.

It is becoming more obvious that northern California for its more complete development requires an open road over the mountains. Heavy snow removal on the roads over high summits presents problems beyond satisfactory solution on existing roads or with equipment now available. The most practicable means of obtaining such a road would appear to be the construction of a route that would cross the mountains at a lower elevation and encounter less snowfall.

Admitting that northern California is unquestionably entitled to one all-year road across the Sierras the opportunity to lay out this Oroville-Quincy lateral, or Feather River Route, that it will become an integral part of such a road, furnishes sufficient reason for expending whatever sum a high standard road along the river will cost.

There is no traversable road following this route (North Fork). County roads by various routes other than the one described lead as far as Hog Wallow Gap, about 1.5 miles southerly from Jarboe. From Hog Wallow to a point opposite Storrie—the location of the power house being installed by the Feather River Power Company—a road has recently been built by the Great Western Power Company for a distance of 24 miles at a cost of approximately \$330,000. This road utilizes for about one-third of its length the old Utah Construction Company road which has been widened somewhat. The road was built by the Great Western Power Company first, in order to facilitate delivery of material for the construction of a transmission line from Storrie to the valley to carry the power from the Storrie plant, which power is contracted for by the Great Western Power Company. This road will also serve in the future as a means of

access for maintenance of this line and the Caribou line of the Great Western Power Company.

I am advised that the grades of this road are so laid out that improvement of alignment can be made without exceeding our maximum rate. In order to secure better access to the power lines it has undulations that would not be warranted in the location of a highway. While Butte and Plumas counties have contributed to the construction of this road and regard it as a completed portion of the North Fork highway it is doubtful if any portion of it could be followed by a state highway location. In the first place, adverse grade should be reduced as much as possible, and second, the location should be as far from the transmission lines as practicable. This road as built is for the major portion of its length very close to one or both transmission lines and portions of it are dangerously close to the Western Pacific Railroad. See photographs 259 and 263, page 61. The cost of widening and straightening this road to meet the minimum requirements for a state highway would be exorbitant in the matter of so handling excavation as not to injure the transmission lines and in the matter of interference with the towers in the improvement of the alignment. This subject is further discussed under the heading of "Alternates."

Between Storrie and Camp Rodgers several short pieces of the old Utah Construction Company road are found but these are of very limited value even as pioneer roads to aid construction.

Under the direction of Supervisor Wm. Lawrence of Plumas County, a road is being graded from Indian Falls, a resort on the Greenville-Quincy road about 13 miles north of Quincy, down Indian Creek and the East Branch toward Twain. This is a fair county road for very limited traffic and is being built as a part of the North Fork Highway. It will serve Indian Valley better than it will Quincy and above the junction of Indian and Spanish creeks—3 miles below Indian Falls—this road would not be a part of the road to Quincy. It will furnish a better outlet to the territory adjacent to Twain which is now reached by a narrow and steep road connecting with the main road about 5 miles north of Quincy.

Between the present end of this road and the dead end of the Great Western Power Company road at Storrie are 29 miles of road to be built to afford a usable connection. Reports regarding this road placing the length to be built to complete the route as 17 miles are incorrect.

CONCLUSION

The data herein set forth indicate that an interstate route using the major portion of the Middle Fork Route has these advantages:

It is 24.6 miles shorter than any other suitable route.

It will be more easily kept open throughout the year than a route via the North Fork over Lee's Summit. It will cost less than the North Fork Route.

As a road to Quincy the Middle Fork Route will be 7.1 miles shorter than the North Fork Route and will cost \$1,295,727 less.

Considered independently as an interstate route, the Middle Fork will cost \$1,131,975 less than the North Fork Route.

The additional cost of keeping the Middle Fork Route open to Quincy is insignificant.

These disclosures suggested the need of ascertaining the legal status of the Middle Fork Route. I conferred with Attorney General Webb and the Department of Public Works attorney, C. C. Carleton, and subsequently requested a legal opinion from each of these gentlemen. I quote from attorney Carleton's opinion:

January 30, 1928.

Mr. Bert B. Meek,
Director of Public Works,
Sacramento, California.

DEAR SIR: Subject: *Legal problems relating to the location of the state highway between Oroville and Quincy.*

FOREWORD

A massive volume of absorbing interest could be compiled containing the general history of the presentation, promotion and consideration of various routes for a state highway from Oroville to Quincy, as set forth in various engineering, economic and military reports; petitions and resolutions of public and civic bodies; and the official acts and orders of the California Highway Commission from the organization of the Commission, in the year 1911, to the present time.

The files and minutes of the Commission reveal a wealth of information concerning the engineering advantages and disadvantages of the rival routes, their respective scenic attractions and historical associations, and their adaptability, or lack thereof, as logical links in all-year military and interstate highway systems.

But despite the accumulation of this fund of engineering and economic information during the past sixteen years, one of the most important angles of the situation, namely, the legal, has remained unsettled and untested.

To the present time the legal questions involved in the location of this much discussed portion of the state highway system have been moot ones, and, within the past thirty days, for the first time the Attorney General of the State of California has been requested to render a formal opinion as to the legal aspects of the matter; such request being made by you.

It is the purpose of this report to review the legal history of the proposed project, to state some of the legal points arising therefrom, and to indulge in some speculations as to the probable conclusions of the courts should their intervention be sought.

ROUTES FOR A STATE HIGHWAY FROM OROVILLE TO QUINCY UNDER CONSIDERATION

1. North Fork Route.

Which follows the North Fork of the Feather River to its junction with the East Branch at Howells; thence along the East Branch to the junction of Indian Creek and Spanish Creek at Paxton; thence following Spanish Creek to Keddie; thence to Quincy.

2. Ridge Route.

Which follows in a general way the route of the present traveled road from Oroville to Quincy via Buck's Ranch, lying between the North Fork and Middle Fork routes.

3. Middle Fork Route.

Which follows the Middle Fork of the Feather River via Nelson Point to Quincy.

Comparative costs and distances of the routes.

The North Fork Route will be 81 miles in length between Oroville and Quincy, whereas the Middle Fork will be but 73.3 miles in length.

Hence the Middle Fork Route, as between these two cities, will be 7.7 miles shorter than the North Fork route.

As a link in an interstate connection, the Middle Fork route will be 24.6 miles shorter than any other all-year route in that vicinity.

As a road to Quincy, the California Highway Commission's engineers estimate that the Middle Fork Route will cost \$1,295,727 less than the North Fork Route; that, considered independently as an interstate route, the Middle Fork will cost \$1,131,975 less than the North Fork Route to the Nevada state line.

The engineers estimate that the gross cost of the North Fork Route will be \$7,655,607; that of the Middle Fork Route will be \$6,359,880.

It is conceded that the Ridge Route would be shorter and less expensive than the other two routes, the mileage being 66 miles between Oroville and Quincy and the probable cost about \$3,000,000, but the Ridge Route would not provide an all-year road as would the other routes, for the reason that it is blocked by snow for a portion of the year.

The foregoing data are presented as pertinent to questions of directness and practicability to which reference is hereafter made.

The first two state highway bond issues.

In 1910 California passed its first state highways act providing for a bond issue of \$18,000,000.

In 1916 the second state highways act was passed providing for a bond issue of \$15,000,000.

These two acts were referendum measures and provided for the construction of a system of state highways, including county-seat laterals.

Oroville and Quincy were not expressly named in these acts, and the mandate to the State Department of Engineering, the predecessor to the State Department of Public Works now acting through the California Highway Commission, was that it should locate the highways by the most "direct and practicable" routes.

By these acts a very liberal discretion was vested in the state highway officials, they being limited only by the words, "most direct and practicable routes."

It will probably not be seriously urged that if only these two acts were in force at the present time, that a court would annul the action of the California Highway Commission, if, in the exercise of such discretion, it should choose either of the three routes, or modifications thereof, for the final state highway location for a county-seat lateral between Oroville and Quincy.

The general rule of law would apply that the court would not interfere in such a case, unless *bad faith* was clearly shown.

As a matter of history, it may be safely stated that prior to 1919 the Commission, owing to a shortage of funds and considering the large estimate of probable cost of the North Fork Route (the Middle Fork Route not being a serious contender in that day for location honors), was strongly inclined toward the Ridge Route on account of its shorter mileage and lesser expense.

Had the Ridge Route been actually adopted at that time such location would have been legally unassailable.

Constitutional amendment of 1919.

At a special election held July 1, 1919, the people of the State of California adopted a constitutional amendment (section 2, article XVI) providing for the issuance of state highway bonds to the amount of \$40,000,000 to complete the projects contemplated by the two previous state highway bond issues in amounts \$18,000,000 and \$15,000,000 respectively (including county-seat laterals), and to construct thirty-one additional projects specified in the constitutional amendment.

One of the "additional" highways was designated "Feather River Route, Oroville to Quincy."

Feather River Route, Oroville to Quincy.

The "Feather River Route, Oroville to Quincy," is described as an "additional highway," "to be located by the most direct and practical route," in the \$40,000,000 highway bond constitutional amendment of 1919.

The significance of such designation has now become the subject of legal interpretation and research.

The North Fork Route was the one followed by a transcontinental railroad, whose nationally known slogan for years has been the "Feather River Route," and which, very naturally, resulted in the North Fork highway route also being called the "Feather River Route." The snow free, non-snowshed features of this railroad gave impetus to the agitation for an all-year road via the North Fork Route. The press in 1919, and prior thereto, alluded to the North Fork Route as the "Feather River Route." Maps issued as campaign publicity (but not as official maps, accompanying the bond election) preliminary to the special election of July 1, 1919, set forth the North Fork Route, its mileage, and the estimate of cost thereof as made by the California Highway Commission's engineers.

But the most important contemporaneous piece of evidence is the following statement of the Engineering Department of the California Highway Commission issued in 1919 just prior to the special election, which is in words and figures following:

"FEATHER RIVER ROUTE, OROVILLE TO QUINCY, in Butte and Plumas counties, about 92 miles in length, to be graded in the mountainous portion, and paved in the valley if there is sufficient money.

Under the former bond issue a road from Oroville to Quincy was included and \$850,000 is now added to cover the additional cost of building the road on the Feather River Canyon Route instead of via Buck's Ranch as heretofore contemplated.

This road, following the canyon of the North Fork of Feather River, through the mountains, will, in connection with the present Beckwith Pass road, furnish a practically all-winter route across the central Sierra Nevada, as well as open up a beautiful region, abounding in fish and game, to the tourist.

Among California's most valuable assets must be counted her mountain playgrounds, and this road will open up to the motoring public a number of beautiful spots, now accessible only by railroad, if at all.

From Quincy, the easterly terminus of the proposed road, some of the most attractive spots in the entire Sierras are within easy reach."

This was an explanation prepared by the department for use in the campaign.

Concluding this portion of the report, it can be stated without fear of successful contradiction, that the real reason why the North Fork Route has not been built has been because of shortage of funds to "tackle the job." To the present time such construction has been financially forbidden.

As a matter of record, the California Highway Commission adopted the North Fork Route on the 20th day of October, 1921, but on January 4, 1923, this action was rescinded by the following action:

"It appearing that the surveys of the proposed highway up the North Fork of the Feather River connecting Oroville and Quincy have shown that the cost of such a road built to standard width would approximate \$7,000,000 with \$1,500,000 in the bond issue for its construction; that the conditions as imposed by the United States Bureau of Public Roads as a prerequisite to the use of federal funds on this road would unduly obligate and commit California's share of these funds for many years to come to the disadvantage of the state; that the construction of the highway up the North Fork of the Feather River involves complications difficult of solution with the Western Pacific Railroad and the Great Western Power Company which have certain established rights in the canyon secured by prior occupancy, with the possibility of damage actions involving large sums; that the maintenance of the proposed highway up the North Fork would be excessively heavy; it therefore appearing that the surveys along the North Fork of the Feather River have shown that the route does not conform to the mandate of the bond issue for construction along 'the most direct and practical route.'

VOTED, that the vote of the California Highway Commission of October 20, 1921, adopting said route is hereby rescinded, and that the State Highway Engineer be instructed to immediately discontinue all surveys and plans thereon."

No official action has been taken by the California Highway Commission regarding such location subsequent to January 4, 1923, as far as the writer can ascertain.

CONCLUSIONS

First: In the opinion of the writer of this report, the selection of the "North Fork Route" could not be successfully attacked in the courts.

Second: That when the phrase "Feather River Route" was employed, that it was positively "intended" to apply to the so-called "North Fork Route."

Third: That the California Highway Commission can not ignore section 2, article XVI, of the constitution \$40,000,000 bond amendment of 1919 and justify a location on the Middle Fork or any route other than the "North Fork Route" by reason of any authority previously granted by the first two state highway bond acts.

Fourth: That the fact that some other route may be built one million or several million dollars cheaper than the "North Fork Route" or that such routes may be shorter or more suitable links in an interstate highway system, can not be taken into consideration by the California Highway Commission, however feasible or economical they may be, for the reason that the intentional mandate of the law is to build a road from Oroville to Quincy along the "North Fork Route" (by the most direct and practical route adjacent thereto), and the law makes no allusion to any state highway project beyond Quincy or any prospective tie-up with the highway systems of other states.

Fifth: That should the California Highway Commission differ from the foregoing conclusions of the writer, and determine to adopt a route other than the North Fork Route, then the only suggestion that can still be ventured is that no appreciable sum of money be spent on such alternative route until the legality and constitutionality of such location be first sustained by the Supreme Court, after initiation of suitable proceedings for the judicial test thereof.

It would be most presumptuous for the writer to urge that the Supreme Court could not, in its own wisdom, conclude that the legislation did vest in the highway location officials a *paramount and exclusive* discretion in the matter; that the words "Feather River Route" are merely directory and of general application; or that the evidence presented on behalf of the North Fork was not worthy of judicial credence or entitled to be admitted into a judicial record.

In closing this report, permit me to state, for you have invited my frank conclusions herein, that I am firmly convinced that if the case in favor of the "North Fork Route" is fully and forcibly presented, that the court of last resort will determine it to be the route, and the only route contemplated by the constitution of the State of California, and that such an interpretation is justified by the historical facts surrounding its selection by the legislature and the people.

Respectfully submitted,

C. C. CARLETON,

Chief, Division of Contracts and Rights of Way, Department of Public Works.

I quote from Attorney General Webb's opinion :

San Francisco, February 15, 1928.

Hon. B. B. Meek,
Director, Department of Public Works,
Sacramento, California.

DEAR SIR: Under the date of the 17th ult. you submitted for an expression of the views of this office three questions, and indicated your desire to have an opinion thereon prior to the meeting of the Highway Commission to be held on the 16th and 17th of February. The three questions so submitted by you are:

"1. Is this department limited by law in the location to the so-called North Fork Route?

2. Assuming that the so-called Middle Fork Route is shorter and less expensive, is this department vested with the discretion to determine that the Middle Fork location comes within the purview of the state highway legislation, as being 'the most direct and practical route,' and as being covered by the phrase, 'Feather River Route; Oroville to Quincy,' used in a general sense?

3. Assuming that the phrase, 'Feather River Route; Oroville to Quincy,' was intended by section 2, article XVI of the constitution of California (\$40,000,000 bond issue) to mean the North Fork, is this department legally justified, nevertheless, in locating a state highway on the Middle Fork on the theory that this department was given such authority by the first two state highway acts (1909—\$18,000,000 bond issue, and 1915—\$15,000,000 bond issue), before the adoption of section 2, article XVI of the constitution, and that such section 2 expressly described the 'Feather River; Oroville to Quincy' as an additional state highway?"

Following such presentation of your questions you add:

"While the above questions occur to us, yet we desire you to furnish to this department a comprehensive opinion on the subject matter, touching on such other points as may appear to you to be pertinent to this inquiry."

As the answer to these questions in a measure depends upon some facts of history, geography and common knowledge, it seems appropriate that a reference to such facts be first made. * * *

Answering question 1, it is my view that your department is limited by law in the location of the Quincy lateral to the so-called "North Fork Route."

2. My view is that neither the assumption that the "Middle Fork Route is shorter and less expensive," nor the existence or assumption of any other fact would empower or authorize the highway authorities to determine that the Middle Fork location comes within the purview of the state highway legislation.

3. It is my opinion that the authority given to the highway department by the acts of 1909 and 1915 to select the Middle Fork of the Feather River as the route of the Quincy lateral was withdrawn by the act of 1919, and that therefore such authority does not now exist. I am of the further view that the "Feather River Route; Oroville to Quincy," is not "an additional state highway," but is the only highway to Quincy, the construction of which is now authorized by law. * * *

Very truly yours,

U. S. WEBB,
Attorney General.

During the time that the attorneys' reports were in course of preparation, we pursued the engineering study. In fact, this study has continued down to the present moment.

I have believed that before committing the state to an expenditure involving several million dollars, certainly an exhaustive study, both engineering and legal, ought to be made. This has now been done.

I quote from the second engineer's report:

"Like all modern highways in rural California, the proposed highway through the Feather River country will carry, and must be designed to best accommodate, two general types of traffic, namely, recreational or tourist travel, and business or commercial intercourse. An appraisal of the needs of each of these types, as applied to this particular road, is necessary in forming a rational conclusion as to its proper location and design.

The factors which enter into the make-up of the best recreational road are strongly contrasted in some respects to those which go to make up the best road for business or commercial purposes. In the latter

type, for economic reasons, the road must be as short as possible, and free from all obstacles which will retard speed of operation, and at the same time, be safe for the traffic it carries. Modern construction standards will eliminate most of the obstacles to this speed of operation, and will make the road safe, but the routing and location must be depended upon to obtain the shortest distance and to minimize the greatest obstacle to year-around traffic on this particular route, snow. For its use as a business or commercial thoroughfare, therefore, we must look for the route which will serve the present and potential traffic best by reason of the shortest possible distance, and its freedom from snow in the winter season.

Contrasted to the two essentials of a commercial road mentioned above, are the needs of a recreational road. Distance, while important, should be sacrificed, in a rational degree, to make accessible to the tourist his prime objectives, proximity to forest and stream, mountain scenery and the natural beauties, and opportunity for sport and recreation. The other prime requisite for the commercial road, freedom from snow, is of little or no importance on the recreational roads, since such roads are not used during the winter season.

Combining the values both for recreational and commercial traffic of both feasible routes as discussed above, taking into account the population, resources, etc., given in the statistics, and their distribution as shown on the map, it will appear that for the area within the state, the advantages of the North Fork Route outweigh those of the Middle Fork Route by many times, probably more than five to one. This is true, considering future possibilities for the development of this portion of the state as well as present conditions. * * *

Summarizing the above discussion of all traffic from the neighboring states, it appears that the North Fork routing will serve commercial traffic about equally as well as the Middle Fork, and that it will serve all recreational traffic far better. * * *

That portion of this transcontinental traffic which would be influenced by the routing of the Feather River highway, will be benefited most greatly by the route which makes most easily accessible the greatest recreational or touring possibilities. Distance is not an essential, since, if it were, no such traffic would traverse either highway in the Feather River country, but it would all take the shorter route via Donner Lake. * * *

The traffic of the area within the state will be more greatly benefited by the construction of the North Fork Route, as compared to the Middle Fork Route, in the proportion of five to one or more.

Traffic with the neighboring states will be somewhat more greatly benefited by the construction of the North Fork Route than the Middle Fork Route.

Traffic with far distant states will be more greatly benefited by the construction of the North Fork Route, as compared with the Middle Fork Route, in the proportion of about three to one.

Considering the character and volume of traffic the road will handle, and the area of the state to be served and developed, it would appear that the advantages of the North Fork Route, as set forth above, justify its probable greater cost, as compared with the Middle Fork Route.

(Note: Read Temporary State Highway Engineer Morton's report.)

Both by General Webb's and attorney Carleton's reports, you will note that in their opinion a road constructed up the Middle Fork Canyon will not satisfy the law to connect Quincy and Oroville via the Feather River Route, while both attorneys agree that a road built up the North Fork Canyon will satisfy the law.

The Middle Fork Route being precluded from further consideration by the law, is the state justified at this time in beginning the construction of a road up the North Fork Canyon, the cost of which will run into several million dollars before it is completed, or ought we take the view that the cost is too great and thus prolong indefinitely the settlement of this eighteen-year-old controversy, passing a determination of the matter on to subsequent administrations?

You will note that one of the engineers' reports indicates that the Middle Fork will serve Nevada and the East better than the North Fork, but that the North Fork will serve Oregon, Idaho and the north-west country better than the Middle Fork, and that there is less snow between Oroville and Quincy via the North Fork but more snow between Quincy and

the Nevada state line on this route. However, the recreational traffic will be greater out of all proportion than the interstate traffic, and this report indicates a very decided advantage in favor of the North Fork Route for recreational traffic.

I have just returned from a trip with the engineers through the North Fork Canyon and there are no unusual physical obstacles to the construction of a road in this canyon.

Considering the fact that a road up the North Fork Canyon will meet the constitutional requirement to connect Quincy with the state's highway system; that such a road will also serve as a link to an all-year trans-Sierra interstate highway; that it will open up by a direct all-year route vast new scenic and recreational areas; that this is the only county-seat lateral in the state on which not a single dollar has been expended on construction; and that we can now finance one or more convict camps for this project, I recommend that location surveys be immediately started in the North Fork Canyon and construction proceed thereafter as fast as engineering data are complete and funds are available.

Attached hereto please find both engineers' reports and Temporary State Highway Engineer Morton's letter of transmittal. Also please find attached the complete opinions of Attorney General Webb and the Department of Public Works attorney, C. C. Carleton.

All this for your consideration and appropriate action.

Very truly yours,

B. B. MEEK,
Director.

VOTE OF COMMISSION

Upon the conclusion of Mr. Meek's report and recommendation Commissioner Baumgartner made the following motion, which was seconded by Commissioner Harris and adopted by unanimous vote.

That the report and recommendation of the Director of the Department of Public Works on the Oroville-to-Quincy Lateral, State Highway, is hereby accepted and approved:

That the North Fork of the Feather River be and hereby is adopted and designated as the route for the Oroville-to-Quincy Lateral, State Highway;

That the work of construction shall be prosecuted with all due diligence and as rapidly as financially and engineeringly possible.

The beginning of the year 1928 saw increases in the gas tax from 3 to 4 cents taking effect in two states, Arizona and New Hampshire. The Arizona legislation was passed in August. In New Hampshire the rate was increased from 2 to 3 cents early in 1927 and the special session in November boosted the rate another cent.

This makes twelve states which have a 4-cent gas tax, while six states have a higher tax, one having a 4½-cent rate and five having a 5-cent tax.

Fourteen states have the 3-cent tax and one state has 3½. This makes a total of thirty-three states which have a gas tax of 3 cents or more.

Thirteen states have a 2-cent tax. Only two states, New York and Massachusetts, have no gas tax.

Statistics show that more persons have been killed in automobile accidents during the last ten years than were killed in the American forces during the World War. Motor vehicle accidents accounted for 160,390 deaths in the United States between January 1, 1917, and December 31, 1926. The total number of American soldiers, sailors and marines who lost their lives during the World War was 130,326.

Chief Accountant

For Works Department

THE task of bookkeeping books on an annual expenditure of \$30,000,000 is the assignment given E. R. Higgins, recently appointed chief accountant of the Department of Public Works. Before coming to the Department of Public Works Mr.



E. R. HIGGINS.

Higgins was an accountant in the State Department of Finance from 1923 to 1928. He is a graduate of the University of California with the class of 1919.

Mr. Higgins has supervision over the accounting of all of the divisions of the Department of Public Works' expenditures which total approximately \$30,000,000 a year. These expenditures are made under the budget system and

the foundation of the accounting system is this budgetary plan.

PROGRESS REPORTS FROM THE FIELD

ALPINE COUNTY—All roads closed during winter and spring months on account of snow.

AMADOR COUNTY—The grading contract on the Alpine Highway between Jackson and Pine Grove is progressing very satisfactorily. Mr. G. D. Contoules is the contractor.

Work is to start soon on another stretch of the Cosumnes River to Plymouth section of the Mother Lode Highway. \$5,000 has been allotted for this work.

CALAVERAS COUNTY—At the request of the city authorities and at their expense, this district made survey and prepared plans and specifications for paving with asphalt macadam state highway routes through the city of Angels, for which a bond issue was voted by the citizens. On the twentieth of February, seven bids were received and contract was awarded on February 23, 1928, to the Adams Company of Angels Camp.

Improving alignment and widening of Mokelumne River Grade leading to Mokelumne Hill is now under way.

FRESNO COUNTY—Work, consisting of extending and rebuilding all of the old narrow culverts and bridges on Route 4, in Fresno County, is proceeding rapidly.

A construction crew is working on Route 10—"Sierra-to-the-Sea" lateral, widening the roadway, changing line to avoid the creek and building bridges from Coalinga west to the county line. This work is attracting considerable favorable comment from the residents of the district and tourists.

IMPERIAL COUNTY—Two new reconstruction contracts have been awarded in Imperial County. Under one contract, that portion of the El Centro to San Diego highway extending from El Centro to Seeley

will be drained and the pavement will be widened to 20 feet and redecked with asphaltic concrete. Under the second contract a storm water protection system will be constructed along the Los Angeles, Imperial Valley Highway, west of the Salton Sea. This improvement will extend from the Trifolium Canal to the Arroyo Salado wash and covers a large portion of the highway which has been repeatedly damaged by floods.

The 2.3-mile grading project on the Mountain Springs grade between El Centro and San Diego replacing the road destroyed by floods in December, 1916, is now completed.

KERN COUNTY—The recent acceptance of two contracts, one completed by the Valley Paving Company and one by Force-Currihan & McLeod, between Delano and Lerdo, completes the widening to 20 feet of all but 2 miles of the pavement on Route 4 in Kern County.

The mechanical rakes and finishers were used on both jobs and the results secured were very satisfactory.

Wide flat slopes were utilized and all grading was well finished, resulting in a roadway which is pleasing to view as well as to ride on.

A power shovel outfit is working in the Kern River Canyon from Democrat Springs easterly, widening and straightening the road, which was taken over from the county last year.

This work will assist in making one of Kern County's most popular recreational roads more safe for the expected summer traffic.

A survey of the road from Wasco to Famosa on the Cholame lateral has just been completed, preparatory to getting under way some needed improvements on this highway.

KINGS COUNTY—Spring grading work is completed along Route 10 in Kings County and it is hoped to minimize the fire hazard through this important farming country this summer.

LASSEN COUNTY—All work except routine maintenance has been at a standstill in Lassen County for the past two months, due to weather conditions.

The new rotary snow plow which we have stationed between Susanville and Westwood has been doing excellent work, and so far this winter we have had no trouble in keeping the road open for traffic, although the snowfall has been comparatively light.

Plans and estimates are now in the Modoc County line.

MADERA COUNTY—Six and one-half miles of road in Madera County is being advertised for reconstruction, south of Madera. The improvement will consist of widening and resurfacing with asphaltic concrete.

A survey of the highway between Madera and Califa is now under way, preparatory to contracting some necessary reconstruction and widening of this road.

MARIN COUNTY—The Redwood Highway from San Francisco and east bay cities to the Russian River country and the redwoods of Mendocino and Humboldt counties, is attracting much constructive notice.

To meet traffic needs it has become necessary to do much widening and reconstruction work and plans and specifications are being prepared to improve that portion from San Rafael 7 miles northerly to Ignacio and the Black Point road junction.

In the meantime the contract which was let to the Pacific States Construction Company, to surface 0.76 mile through Kentfield with asphaltic concrete 20 feet wide and 2 inches minimum thickness with 2-foot rock shoulders, has just been completed.

MARIPOSA COUNTY—Work by the convict crew on the Yosemite All-year Highway north of Mariposa is progressing satisfactorily. Several line and grade changes have been made which materially widen and straighten this road.

Installation of 6600 lineal feet of standard laminated guard rail has just been completed by Contractor Burnett and the improvement has already proven of value in avoiding serious wrecks.

MENDOCINO COUNTY—The highway just north of the Mendocino County line, connecting the Redwood Highway with the coast via Booneville, known as the "McDonald to the Coast Road," is due for much localized improvement. It is mostly unimproved road and as a start the department has been authorized to widen and straighten the existing road. A number of wooden bridges and culverts are being rebuilt to take care of the drainage pending reconstruction of the road on improved and resurveyed alignment and grades.

MERCED COUNTY—Contractor H. C. Whitty has a crew of men extending culverts and bridges along Route 4 from Merced south to the county line. All of the old 20-foot structures are being extended to care for present and future traffic needs.

Larsen Bros. have completed their contract for 9 miles of gravel shoulders and widening of the embankment on Route 32 from Los Banos easterly to the county line.

MODOC COUNTY—The widening work being done by state forces, between Adin Summit and Canby, is about 70 per cent complete, and has already effected an enormous improvement on this section.

NAPA COUNTY—That section of new highway between Callstoga and Middletown, lying in Lake County, has been widened and several timber bridges built by district maintenance forces.

PLUMAS COUNTY—There has been no actual construction work during the past two months in Plumas County, on account of snow.

A condemnation suit has been filed to clear up the right of way situation across the Lake Almanor causeway, and when the necessary court order is received, the approach to the westerly end will be completed, and this unit thrown open to traffic. This work can be completed in about one week's time after we get access to the ground.

Plans and estimates have been completed for the westerly 6 miles adjoining the Tehama County line, the construction of which is proposed for this year.

RIVERSIDE COUNTY—A survey has been completed on the Mecca-Blythe road and plans are being prepared in the district office to advertise bids for letting a contract. The new improvement will be an extension of the 9-mile oiled gravel section west of Blythe. It will be financed from the additional gasoline tax fund for new construction.

SAN BERNARDINO COUNTY—*Foothill Boulevard*—Contractor Steele Finley has been laying pavement on the Foothill boulevard project since January 27th. Reports from the engineers in the field show substantial daily progress. The present contract extends from San Bernardino westerly through Rialto and Fontana to Cherry avenue, a distance of 9.3 miles. The new pavement is of asphaltic concrete 30 feet wide. The contractor is using mechanical equipment for spreading the material on the road surface. This is a late development in asphaltic concrete paving methods and is being observed with interest by other contractors and engineers.

Redlands to the Riverside County Line—A second pavement reconstruction project in San Bernardino County is under way on the Los Angeles-Imperial Valley Highway between Redlands and the Riverside county line. This contract is rapidly nearing completion. The new pavement will be 20 feet wide with improved shoulders 2½ feet wide along each edge.

Crest Route—Contractor J. G. Donovan has four paver shovels in operation on the U. S. Bureau of Public Roads project covering 3.54 miles from the "Pass" to the "Incline" on the new "high gear" road to the summit of the San Bernardino mountains. This project is a part of the heavy construction along the face of the mountain in the ascent from the "Pass" between Waterman and Devils Canyon to Squirrel Inn. By completing this project, the Bureau will have contributed a considerable share in the construction of this highway.

Grading is under way by state forces along the Rim of the World Drive between Running Springs Park and Squirrel Inn. This work is advancing westerly from the Running Springs end to a point west of the Allison Ranch. This new work on the Crest of the range is clearly visible from the whole San Bernardino Valley as a white line along the mountain top.

TEHAMA COUNTY—The surfacing of the 12-mile stretch of the Susanville road east of Red Bluff is nearing completion, and with a normal amount of rain, we will have a well compacted gravel road over this section for summer traffic.

The work of widening and building up shoulders between the Glenn County line and Corning has just been completed by state forces.

TRINITY COUNTY—The bridge across the Trinity River at Cedar Flat was completed last week, and we are now constructing the approach fills with state forces. The bridge should be open to traffic by March 15th.

TUOLUMNE COUNTY—Plans are in progress for resurfacing a portion of the state highway from Keystone to Jamestown. Preliminary plans and right of way negotiations are under way for proposed construction east of Sonora.

The Big Oak Flat road is being placed in excellent shape preparatory to summer travel. Mountain Pass to Tuolumne River has been placed in shape for oiling early in the spring and Priest's Grade is now being resurfaced. Soldier's Gulch on the Mother Lode Highway has been widened and surfaced and is now in excellent condition. Before the state took over the

Mother Lode Highway, Soldier's Gulch was extremely narrow and dangerous and is now vastly improved.

SHASTA COUNTY—The section of the Pacific Highway now under construction between La Moine and Shotgun Creek is nearing completion, and the work should be completed early in May. The grading is about 95 per cent complete at this time, and the gravel surfacing is rapidly following.

The widening work between Redding and Cottonwood has been discontinued the past six weeks on account of wet weather.

The widening of a few dangerous places by state forces, at Manzanita Hill, about 30 miles east of Redding, has been completed, and this work, although not very extensive, has effected a much appreciated improvement to the road.

The convict camp 25 miles west of Redding has been on the job four months, and has made excellent progress.

The widening of the narrow cuts between Redding and Tower House has just been completed by state forces.

SISKIYOU COUNTY—Outside of routine maintenance, there has been very little new work in Siskiyou County the past two months.

There are several points on the Pacific Highway in Siskiyou County which, during the winter season, become icy and dangerous for traffic. We have made a practice of sanding these spots when necessary, and have recently completed shelters at numerous points along the road, for storing sand, thus making a dry supply available at all times.

SACRAMENTO COUNTY—The Arno cut-off contract, a grading and gravel surface job between Sacramento and Galt, has been tied up by high water. Mankel & Staring are the contractors on this piece of construction.

SAN BENITO COUNTY—The approaches to the newly constructed bridge over Pacheco Creek are being graded and surfaced with rock by a district maintenance crew.

SAN FRANCISCO COUNTY—The portion of the Bay Shore Highway lying within the county is to be improved in the near future by the city of San Francisco. A bond issue of \$9,000,000 recently voted by the city to build highways, includes this section and the plans and specifications are being prepared by the city for contracts to be let in the near future.

SAN JOAQUIN COUNTY—The new entrance north-east of Stockton, a grading and gravel surface job, is nearly complete. The contractors, Irey & Holden, however, have been prevented from proceeding with the work due to wet weather.

Bids will be opened March 28th for placing cement concrete pavement between Mossdale and French Camp.

SOLANO COUNTY—Preliminary plans and right of way negotiations are complete for proposed line change north of Cordelia.

STANISLAUS COUNTY—Bids were opened in the district office on February 9, 1928, for paving a line change in Ceres, Stanislaus County. The contract is for grading and placing an asphaltic concrete pavement. The Standard Paving Company of Modesto was low bidder, and the contract was awarded to them on February 16, 1928.

TULARE COUNTY—A survey crew under Resident Engineer Paul Wilcox is gathering data for a reconstruction in Tulare County, from the county line north through Earlimart.

YOLO COUNTY—Preliminary plans are complete for widening, shouldering, and second story paving about one mile east and west of the Causeway.

Teichert & Son, Sacramento, \$6,590. Contract awarded to Standard Paving Co. for \$6,505.

MONTEREY COUNTY—Timber bridge across Salmon Creek. Dist. V, Rt. 56, Sec. A. Engineer's Est. \$5,840. Bids opened Feb. 29th as follows: Theo. M. Maino, San Luis Obispo, \$3,988.22; C. D. Todd, Pacific Grove, \$4,840; W. J. Smith, San Luis Obispo, \$5,492. Contract awarded to Theo. M. Maino for \$3,988.22.

SUTTER COUNTY—Causeway across the Sutter By-pass on the Yuba City to Knights Landing highway. Dist. III. Engineer's Est. \$222,964.66. Bids opened Feb. 17th as follows: D. G. Jones, Stockton, \$252,711.88; Lord & Bishop, Napa, \$226,082.24; Ben G. Gerwick, Inc., San Francisco, \$267,915.74; Macdonald & Kahn, Inc., San Francisco, \$233,423.62; Holdener Construction Co., Sacramento, \$222,598.49; Peter F. Bender, No. Sacramento, \$220,305.44; A. W. Kitchen, San Francisco, \$247,641.42; C. E. Green & L. Worrel, Los Angeles, \$231,879.04; Chas. & F. N. Steffen, San Diego, \$224,459.96; C. W. Wood, Stockton, \$232,981.40; M. E. McGowan, San Francisco, \$263,990.60; J. F. Knapp, Stockton, \$214,759.89; Frederickson & Watson, Oakland, \$235,192.76; Jasper-Stacy Co., San Francisco, \$264,059.14; C. J. Nystedt, Stockton, \$222,830.22; The Duncan-Harrelson Co., San Francisco, \$244,646.18; Morrison-Knudson Co., Boise, Idaho, \$210,942.40; Healy-Tibbitts Const. Co., San Francisco, \$241,825.40. Contract awarded to Morrison-Knudson Co., Boise, Idaho, for \$210,942.40.

LOS ANGELES COUNTY—Constructing buildings, etc., at maintenance yard at La Crescenta. Dist. VII, Rt. 9, Sec. A. Engineer's Est. \$5,806. Bids opened Feb. 16th as follows: Jeff Clark, Gardena, \$5,390; A. O. Nelson, Pasadena, \$4,776; Joe Orosel, Los Angeles, \$6,878; Johnson Const. Co., Los Angeles, \$7,276; J. and B. Const. Co., Los Angeles, \$5,584.50. Contract awarded to A. O. Nelson for \$4,776.

EL DORADO COUNTY—0.49 miles to be graded between Shingle Springs and El Dorado. Dist. III, Rt. 11, Sec. B. Engineer's Est. \$10,131.50. Bids opened Feb. 26th as follows: L. C. Seidell, San Francisco, \$9,902; Nate Lovelace, Oakland, \$6,444; Mankel & Staring, Sacramento, \$10,038; G. F. Finnell, Sacramento, \$11,368; Mathews Const. Co., Sacramento, \$5,923; C. W. Wood, Stockton, \$3,914.50; J. P. Reeves, Sacramento, \$10,990.50; Tieslau Bros., Berkeley, \$10,077.50. Contract awarded to Nate Lovelace for \$6,444.

SAN DIEGO COUNTY—Two miles of grading from 3 miles southeast of Pine Valley to Buckman Springs. Dist. VII, Rt. 12, Sec. E. Engineer's Est. \$64,189.25. Bids opened Feb. 23d as follows: R. Johnson, Glendale, \$61,714.50; Jahn & Bressi, Los Angeles, \$46,948.75; Pioneer Transfer Co., Calexico, \$63,342; Kuhn-Lang Co., Los Angeles, \$49,388; Ernest Ward, Los Angeles, \$54,525; Charles E. Pitzer, El Centro, \$69,641.60. Contract awarded to Jahn & Bressi for \$46,948.75.

IMPERIAL COUNTY—Between Seeley and El Centro, 7.2 miles to be widened and surfaced with asphalt concrete. Dist. VIII, Rt. 12, Sec. C. Engineer's Est. \$188,235. Bids opened Feb. 29th as follows: J. C. Compton, Roseville, \$200,097.50; Jahn & Bressi Const. Co., Los Angeles, \$150,845.60; Carl Pleasant, Phoenix, Arizona, \$211,925.45; R. E. Hazard Const. Co., San Diego, \$175,220; Southwest Paving Co., Los Angeles, \$170,764; Pioneer Transfer Co., Calexico, \$163,675.60; Steele Finley, Santa Ana, \$175,734. Contract awarded to Jahn & Bressi Const. Co. of Los Angeles for \$150,845.

SONOMA COUNTY—Approaches to Sonoma Creek bridge. Dist. IV, Rt. 8, Sec. A-B. Engineer's Est. \$18,433.05. Bids opened Feb. 29th as follows: McDonald & Maggiora, Sausalito, \$22,376.20; Tieslau Bros., Berkeley, \$17,618.35; George Ellinwood Finnell, Sacramento, \$22,548.80; J. V. Galbraith, Petaluma, \$19,681.05; Stanley P. Cooley, Palo Alto, \$22,742.05; P. L. Burr, San Francisco, \$22,230.55; W. J. Taylor, Palo Alto, \$27,719.85. Contract awarded to Larsen Bros. of Los Banos. Contractor reserved right to omit oil treatment from surfacing. This was omitted making their price \$14,699.55.

SACRAMENTO COUNTY—Undergrade crossing (Southern Pacific tracks) at Brighton. Dist. III, Rt. 11, Sec. B. Engineer's Est. \$84,541.70. Bids opened March 7th as follows: Parker Schram Co., Portland, Oregon, \$76,986.50; E. B. Skeels, Roseville, \$81,623.05; W. A. Bechtel Co., San Francisco, \$76,672; Mathews Construction Co., Sacramento, \$76,258.25; C. W. Wood, Stockton, \$79,999.75; McDonald and Maggiora, Sausalito, \$81,074.10; McGillivray Const. Co., Sacramento, \$62,618.50; Frederickson & Watson Const. Co., Oakland, \$79,764.78; Holdener Const. Co., Sacramento, \$73,706.24; Lord and Bishop, Napa, \$91,952.25.

IMPERIAL COUNTY—Between Trifolium Drainage

Record of Bids and Awards

DIVISION OF HIGHWAYS

STANISLAUS COUNTY—Grading and paving with asphaltic concrete 20 feet wide, 0.2 of a mile, situated north of Ceres. Dist. X, Rt. 4, Sec. A. Engineer's Est. \$7,162.50. Bids opened Feb. 9th as follows: Standard Paving Co., Modesto, \$6,305; A.

Canal and Arroyo Salada Wash, 19.7 miles of drainage ditches and dykes and 8 timber bridges. Dist. VIII, Rt. 26, Sec. B.C.D. Engineer's Est. \$77,985.50. Bids opened March 7th as follows: D. A. Foley Const. Co., Los Angeles, \$72,383; Morrison-Knudson Co., Boise, Idaho, \$4,005; Grunwald & Tudor, Los Angeles, \$76,695.50; Kuhn-Lang Co., Los Angeles, \$70,050.80; Campbell-Reichert Co., Alhambra, \$65,149.60; Watson & Sutton, San Diego, \$61,677.76; Immel & Robbins, Ventura, \$63,304; Holdener Const. Co., Sacramento \$79,151.75; George Herz & Co., San Bernardino, \$71,581; Pioneer Transfer Co., Calexico, \$62,760; M. Blumenkranz, Los Angeles, \$82,769; Charles E. Pitzer, El Centro, \$77,359.10; Vezu Bros. Stone Co., Wineville, \$99,152.50; Callahan Const. Co., Los Angeles, \$58,478; Conway & Morrow, Brawley, \$57,622.33; Butterfield Const. Co., San Diego, \$66,676; R. Johnson, Glendale, \$93,310; Ken Hodgman, Hollywood, \$124,715. Contract awarded to—

SAN LUIS OBISPO COUNTY—1.9 miles north of San Luis Obispo 0.3 of a mile to be graded and surfaced with waterbound macadam. Dist. V, Rt. 2, Sec. D. Engineer's Est. \$13,615. Sandercock Transfer Co., San Luis Obispo, \$16,093; Tiestlau Bros., Berkeley, \$15,480.50; W. A. Dontanville, Salinas, \$14,393.50; J. F. Collins, Stockton, \$11,675. Contract awarded to J. F. Collins.

MADERA COUNTY—Between Tharsa and Arcola School, 6.5 miles to be paved with asphalt concrete. Dist. VI, Rt. 4, Sec. A. Engineer's Est. \$150,132. Bids opened March 14th as follows: Thompson Bros., Fresno, \$159,963; J. C. Compton, Roseville, \$145,495; A. Teichert & Son, Sacramento, \$133,299; Carl Pleasant, Phoenix, Arizona, \$140,743.50; Allied Contractors, Inc., Omaha, Nebraska, \$139,862.50; Warren Const. Co., Oakland, \$137,096.50; Valley Paving & Const. Co., Visalia, \$130,336; The Callahan Const. Co., Los Angeles, \$120,683; Force, Curran & McLeod, Oakland, \$129,052.50.

DEL NORTE COUNTY—Between Wilson Creek and Crescent City, 15 miles to be surfaced with crushed rock or gravel. Dist. I, Rt. 1, Sec. B. Engineer's Est. \$27,145. Bids opened March 14th as follows: D. McDonald, Sacramento, \$34,190; Weber Const. Co., Crescent City, \$26,067.50; W. C. Elsemore, Eureka, \$28,810; Smith Bros., Co., Eureka, \$27,870; Tiestlau Bros., Berkeley, \$32,975; Montford & Armstrong, Sacramento, \$35,957.

DIVISION OF ARCHITECTURE

STATE LIBRARY AND COURTS BUILDING (Sacramento)—Mural painting work on south wall of the main reading room. Contract awarded to Maynard Dixon, 728 Montgomery St., San Francisco, \$9,500.

WOMAN'S RELIEF CORPS HOME (near Santa Clara)—Drilling and testing water well. Bids opened Feb. 7th as follows: John L. Smith, San Jose, \$843; J. Fred Holthouse, Santa Clara, \$1,100. Contract awarded to John L. Smith.

INDUSTRIAL HOME FOR ADULT BLIND (Oakland)—Addition to shop building. Bids opened Feb. 7th as follows: Office Est., \$14,072. Joe Piasecki, San Francisco, \$11,110; Jacobs & Pattiani, Oakland, \$11,221; Herbert K. Henderson, Oakland, \$11,368; John M. Bartlett, Oakland, \$11,446; J. B. Bishop, Oakland, \$11,682; Heath & Wendt, Berkeley, \$11,956; The Miner Co., Richmond, \$12,289; T. D. Courtright, Oakland, \$12,511; A. Frederick Anderson, Oakland, \$12,577; C. M. Bostrom, Oakland, \$12,867; J. A. Bryant, San Francisco, \$12,995; Spivock and Spivock, San Francisco, \$13,000; G. A. Scott, Oakland, \$13,100; Geo. Swanstrom, Oakland, \$13,144; Emil Person, Berkeley, \$13,293; Clancy Bros., San Francisco, \$13,460; F. R. Siegrist Co., San Francisco, \$13,600; John E. Branagh, Oakland, \$13,700; Leibert & Trobeck, San Francisco, \$13,740; B. S. Macintyre, Oakland, \$13,760; Peter Sorensen, San Francisco, \$14,318; Sullivan & Sullivan, Oakland, \$14,490; J. S. Hannah, San Francisco, \$14,500; E. K. Nelson, San Francisco, \$14,717; E. T. Leiter & Son, Oakland, \$14,737; F. C. Amorosa, San Francisco, \$15,970. Contract awarded to Joe Piasecki, San Francisco for \$11,110.

STATE AGRICULTURAL PARK—Installation of water system. Bids opened Feb. 14th as follows: Office Est., \$17,848. James Young, Oakland, \$16,875; Latourrette-Pical Co., Sacramento, \$11,360; E. W. Redman, Fresno, \$11,795; H. Gould, Sacramento, \$12,457; W. H. Larsen, Sacramento, \$14,889; Hateley

& Hateley, Sacramento, \$15,222; Scott Plumbing Co., Sacramento, \$16,495. Contract awarded to James Young, Oakland for \$10,875.

STATE AGRICULTURAL PARK—Concrete work on Manufacturing Building repairs. Bids opened Feb. 17th as follows: Engineer's Est., \$689. A. R. Marquering, Sacramento, \$550; Olmsted, Field & Conard, Sacramento, \$616; J. F. Anderson, N. Sacramento, \$684; F. E. Provost, Sacramento, \$690; Geo. McDonald, Sacramento, \$860; C. J. Hopkins, Sacramento, \$909. Contract awarded to Olmsted, Field & Conard for \$616.

STATE LIBRARY AND COURTS BUILDING (Sacramento)—Mural painting work. Bids opened Feb. 20th as follows: Frank Van Sloun, San Francisco, \$8,400; Helen K. Forbes, San Francisco, \$10,000; Charles Stafford Duncan, San Francisco, \$15,000. Contract awarded to Frank Van Sloun for \$8,400.

WATER PERMITS AND APPLICATIONS

Permits

Permits to appropriate water issued by the Department of Public Works, Division of Water Rights, during the month of February, 1928:

EL DORADO COUNTY—Permit 2965, Application 4182; issued to City of Sacramento, Sacramento Feb. 13, 1928, for 300 c.f.s. and 210,000 a.f. from Silver Creek and S. Fk. American River in Sec. 4, T. 11 N., R. 13 E., Sec. 20, T. 12 N., R. 14 E., and Sec. 1, T. 11 N., R. 14 E., for irrigation of 49,900 acres. Estimated cost \$29,200,000.

FRESNO COUNTY—Permit 2966, Application 5545; issued to San Joaquin Light & Power Corp., Fresno, Feb. 15, 1928, for 0.035 c.f.s. from unnamed spring in Sec. 2, T. 10 S., R. 22 E., for domestic purposes in Sec. 3.

PLUMAS COUNTY—Permit 2964, Application 5057; issued to Feather River Trust, San Francisco, Feb. 9, 1928, for 5 c.f.s. from Dogwood Cr. in Sec. 2, T. 22 N., R. 8 E., for power and domestic purposes in Sec. 35, T. 23 N., R. 8 E. Estimated cost \$15,000.

Permit 2965, Application 5232; issued to J. N. Evans Estate Co., Reno, Nev., Feb. 17, 1928, for 200 acre ft. per annum from Taylor Lake in Sec. 35, T. 27 N., R. 11 E., for irrigation and stock use on 510 acres. Estimated cost \$1,000.

RIVERSIDE COUNTY—Permit 2959, Application 4469; issued to John Terribilini, San Bernardino, Feb. 7, 1928, for 0.2 c.f.s. from underground water in Sec. 2, T. 4 S., R. 1 E., for domestic and irrigation on 30 acres. Estimated cost \$4,000.

Permit 2960, Application 4711; issued to John Terribilini, San Bernardino, Feb. 7, 1928, for 0.17 c.f.s. from underground water in Sec. 2, T. 4 S., R. 1 E., S. B. M., for domestic and irrigation on 30 acres. Estimated cost \$4,000.

Permit 2961, Application 4511; issued to H. S. Goetz, Los Angeles, Feb. 7, 1928, for 0.12 c.f.s. and 2 acre-feet from unnamed spring in Sec. 11, T. 4 S., R. 1 E., S. B. for irrigation of 31 acres. Estimated cost \$250.

SACRAMENTO COUNTY—Permit 2963, Application 5398; issued to E. C. Chatterton, Roseville, Feb. 8, 1928, for 0.5 c.f.s. from Rio Linda or Dry Creek in Sec. 23, T. 10 N., R. 5 E., for irrigation on 40 acres. Estimated cost \$700.

SAN BERNARDINO COUNTY—Permit 2970, Application 5692; issued to B. Dade Davis San Bernardino, Feb. 20, 1928, for 0.075 c.f.s. from unnamed spring in Sec. 4, T. 1 N., R. 2 W., for domestic purposes. Estimated cost \$3,500.

SAN MATEO COUNTY—Permit 2967, Application 4847; issued to Peninsula Farms Co., Pescadero, Feb. 16, 1928, for 1.5 c.f.s. from Gazos Creek in Sec. 11, T. 9 S., R. 5 W., for irrigation, domestic and fire protection on 290 acres. Estimated cost \$20,000.

Permit 2968, Application 4848; issued to Peninsula Farms Co., Pescadero, Feb. 16, 1928, for 2.67 c.f.s. from Butano Cr. in Sec. 9, T. 8 S., R. 5 W., for irrigation and domestic purposes on 880 acres. Estimated cost \$30,000.

SANTA BARBARA COUNTY—Permit 2971, Application 5745; issued to Horace O. Ensign, Newport Beach, Feb. 20, 1928, for 0.025 c.f.s. from 2 unnamed springs in Sec. 21, T. 10 N., R. 28 W., for domestic purposes. Estimated cost \$1,200.

TRINITY COUNTY—Permit 2972, Application 5616; issued to B. N. Trask, Peanul, Feb. 29, 1928, for 1.5

c.f.s. from Salt Creek in Sec. 20, T. 30 N., R. 11 W., for irrigation of 120 acres in Secs. 19 and 20. Estimated cost \$300.

TULARE COUNTY—Permit 2962. Application 5687; issued to Howell Bone, Miramonte, Feb. 8, 1928, for 0.005 c.f.s. from unnamed spring in Sec. 8, T. 14 S., R. 28 E., for domestic and industrial purposes. Estimated cost \$300.

Applications

Applications for permit to appropriate water filed with the State Department of Public Works, Division of Water Rights, during the month of February, 1928.

BUTTE COUNTY—Application 5825; Frances J. Young, Oroville, for 0.5 c.f.s. from Prairie Slough tributary to Feather River, to be diverted in Sec. 35, T. 18 N., R. 3 E., M. D. M., for irrigation purposes on 19 acres.

DEL NORTE COUNTY—Application 5843; C. R. Ward & J. L. Ward, Crescent City, for 2 c.f.s. from unnamed stream tributary to Smith River, to be diverted in Sec. 12, T. 17 N., R. 2 E., H. M., for power and domestic purposes, 27 t.h.p. to be developed. Estimated cost \$2,000.

FRESNO COUNTY—Application 5817; Miller & Lux, Inc., San Francisco, for 300 c.f.s. from San Joaquin River, to be diverted in Sec. 20, T. 13 S., R. 15 E., M. D. M., for irrigation purposes on 54,000 acres. Estimated cost \$510,000.

Application 5819; Miller & Lux, Inc., San Francisco, for 572 c.f.s. from San Joaquin River, to be diverted in Sec. 12, T. 11 S., R. 13 E., M. D. M., for irrigation purposes on 45,745 acres. Estimated cost \$203,000.

Application 5820; Miller & Lux, Inc., San Francisco, for 735 c.f.s. from San Joaquin River, to be diverted in Sec. 19, T. 13 S., R. 15 E., M. D. M., for irrigation purposes on 58,796 acres. Estimated cost \$294,000.

HUMBOLDT COUNTY—Application 5829; R. C. McCreary, Eureka, for 0.02 c.f.s. from unnamed spring tributary to Mattole River, to be diverted in Sec. 19, T. 1 S., R. 1 W., H. M., for domestic purposes. Estimated cost \$250.

KERN COUNTY—Application 5827; John L. Hooper, Weldon, for 30 c.f.s. from Kern River, to be diverted in Sec. 15, T. 27 S., R. 32 E., M. D. M., for power purposes. 33 t.h.p. to be developed. Estimated cost \$3,000.

Application 5822; J. R. Blanco, Maricopa, for 0.025 c.f.s. from unnamed spring, to be diverted in Sec. 29, T. 28 S., R. 31 E., M. D. M., for domestic and stock purposes. Estimated cost \$850.

LOS ANGELES COUNTY—Application 5846; Young Men's Christian Association, Long Beach, for 0.08 c.f.s. from Falls Canyon tributary to West Fk. San Gabriel River, to be diverted in Sec. 19, T. 2 N., R. 11 W., S. B. M., for domestic purposes.

Application 5847; B. F. Burkhardt, Littlerock, for 0.25 c.f.s. from unnamed spring tributary to Middle Fk. of Palmett Cr., to be diverted in Sec. 23, T. 4 N., R. 10 W., S. B. M., for irrigation and domestic purposes on 50 acres.

MADERA COUNTY—Application 5818; Miller & Lux, Inc., San Francisco, for 306 c.f.s. from San Joaquin River, to be diverted in Sec. 25, T. 13 S., R. 15 E., M. D. M., for irrigation purposes on 16,516 acres. Estimated cost \$75,000.

Application 5821 Miller & Lux, Inc., San Francisco, for 277 c.f.s. from San Joaquin River, to be diverted in Sec. 22, T. 13 S., R. 16 E., M. D. M., for irrigation purposes on 22,170 acres. Estimated cost \$75,000.

Application 5823; Miller & Lux, Inc., San Francisco, for 175 c.f.s. from San Joaquin River, to be diverted in Sec. 8, T. 13 S., R. 17 E., M. D. M., for irrigation purposes on 14,238 acres. Estimated cost \$131,750.

MERCED COUNTY—Application 5826; Newman Land Company, Modesto, for 10 c.f.s. from Mud Slough tributary to San Joaquin River, to be diverted in Sec. 23, T. 7 S., R. 9 E., M. D. M., for irrigation purposes on 480 acres. Estimated cost \$3,000.

MONO COUNTY—Application 5824; Champion Sillimanite, Inc., Bishop, for 2.50 c.f.s. from Milner Creek, to be diverted in Sec. 18, T. 4 S., R. 33 E., M. D. M., for power purposes. 200 t.h.p. to be developed. Estimated cost \$30,000.

Application 5831; Dept. of Natural Resources, Division of Fish and Game, Sacramento, for 3 c.f.s. from Reversed and Fern creeks tributary to Rush Creek, to be diverted in Sec. 21, T. 2 S., R. 26 E., M. D. M., for fish hatchery and domestic purposes. Estimated cost \$300.

NAPA COUNTY—Application 5841; A. Kempkey, San Francisco, for 10 c.f.s. and 10,000 a.f. per annum from Conn Creek tributary to Napa River, to be diverted in Sec. 1, T. 7 N., R. 5 W., M. D. M., for

irrigation purposes on 20,000 acres. Estimated cost \$5,000,000.

PLACER COUNTY—Application 5830; North Fork Ditch Co., Sacramento, for 35 c.f.s. and 300 a.f. per annum from North Fork American River tributary to Sacramento River, to be diverted in Sec. 23, T. 12 N., R. 8 E., M. D. M., for irrigation and domestic purposes on 5090 acres. Estimated cost \$50,000.

RIVERSIDE COUNTY—Application 5842; J. O. Blackburn, Hemet, for 0.023 c.f.s. from Bee Canyon Spring, to be diverted in Sec. 12, T. 5 S., R. 1 E., S. B. M., for irrigation and domestic purposes. Estimated cost \$1,000.

SACRAMENTO COUNTY—Application 5828; H. E. Blodgett, Rio Linda, for 0.11 c.f.s. from Dry Creek tributary to Sacramento River, to be diverted in Sec. 8, T. 10 N., R. 5 E., M. D. M., for irrigation purposes on 9 acres. Estimated cost \$350.

SAN BERNARDINO COUNTY—Application 5834; Harry L. Scott, Etiwanda, for 0.15 c.f.s. from unnamed springs, to be diverted in Sec. 9, T. 1 N., R. 6 W., S. B. M., for irrigation and domestic purposes on 80 acres. Estimated cost \$5,000.

SAN DIEGO COUNTY—Application 5835; G. M. Jones, Ocean Park, for 2000 a.f. per annum from Hellhole Creek tributary to Salton Sink, to be diverted in Sec. 11, T. 11 S., R. 5 E., S. B. M., for irrigation and domestic purposes on 600 acres.

Application 5836; Malcolm B. Woods, Los Angeles, for 75 c.f.s. and 74 a.f. per annum from Coyote Creek, to be diverted in Secs. 22 and 23, T. 9 S., R. 5 E., S. B. M., for power purposes. Estimated cost \$6,000,000.

SANTA BARBARA COUNTY—Application 5832; Lincoln H. Reed, Davis, for 0.50 c.f.s. from San Miguelito Creek tributary to Santa Ynez River, to be diverted in Sec. 4, T. 6 N., R. 34 W., S. B. M., for irrigation purposes on 7 acres.

Application 5833; Daniel J. Filippioni, Santa Maria, for 0.035 c.f.s. from spring in Kelly Canyon tributary to Cuyama River, to be diverted in Sec. 34, T. 11 N., R. 29 W., S. B. M., for domestic and stock purposes. Estimated cost \$350.

Application 5840; W. H. Step, Santa Ynez, for 0.025 c.f.s. from spring, to be diverted in Sec. 32, T. 6 N., R. 29 W., S. B. M., for domestic purposes.

SIERRA COUNTY—Application 5837; Emmett H. Hurlbut, Verdugo City, for 12.50 c.f.s. from Van Joan Creek tributary to N. Fk. Yuba via Jim Crow Creek, to be diverted in Sec. 6, T. 19 N., R. 11 E., M. D. M., for placer mining purposes. Estimated cost \$2,500.

SISKIYOU COUNTY—Application 5816; Woodfill & Barry, Sawyers Bar, for 3 c.f.s. from Eddy Gulch tributary to N. Fk. of Salmon River, to be diverted in Sec. 33, T. 49 N., R. 11 W., M. D. M., for hydraulic mining purposes. Estimated cost \$1,000.

Application 5829; Great Northern Quicksilver Mines, Inc., Oakland, for 0.75 c.f.s. from East Fork and West Fork Empire Cr. tributary to Klamath River, to be diverted in Secs. 12, 13 and 14, T. 47 N., R. 8 W., M. D. M., for mining and domestic purposes.

SONOMA COUNTY—Application 5844; Frank P. Grace Co., Healdsburg, for 1.31 c.f.s. from Russian River tributary to Pacific Ocean, to be diverted in Sec. 33, T. 9 N., R. 9 W., M. D. M., for irrigation purposes on 105 acres.

STANISLAUS COUNTY—Application 5845; Atlas Investment Co., Modesto, for 14 c.f.s. from Tuolumne River tributary to San Joaquin River, to be diverted in Sec. 16, T. 4 S., R. 8 E., M. D. M., for irrigation purposes on 160 acres. Estimated cost \$1,500.

SUTTER COUNTY—Application 5823; L. Y. Mattes and C. E. Sampson, 1003 Higgins Bldg., Los Angeles, for 1.87 c.f.s. from Morrison Slough of Reclamation Dist. 2056, to be diverted in Sec. 1, T. 16 N., R. 2 E., M. D. M., for irrigation purposes on 75 acres. Estimated cost \$1,000.

Application 5849; D. C. Smith, et al., Meridian, for 26 c.f.s. from Sutter Basin By-pass tributary to Sacramento River, to be diverted in Secs. 32 and 33, T. 15 N., R. 2 E., for irrigation purposes on 2200 acres. Estimated cost \$2,000.

TULARE COUNTY—Application 5848; A. A. Bisiri, Los Angeles, for 6.001 c.f.s. from Mosquito Creek tributary to East Fk. of Kaweah River, to be diverted in Sec. 16, T. 17 S., R. 31 E., M. D. M., for domestic purposes.

VENTURA COUNTY—Application 5850; Bolsa Chica Oil Corp., Los Angeles, for 0.05 c.f.s. from unnamed spring, to be diverted in Sec. 5, T. 4 N., R. 18 W., S. B. M., for mining and domestic purposes.

ROSTER
DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA

C. C. YOUNG, *Governor*

B. B. MEEK, *Director, Department of Public Works*

CORNING DE SAULES, *Deputy Director, Department of Public Works*

GEORGE C. MANSFIELD, *Editor, California Highways and Public Works*

DIVISION

of

HIGHWAYS

CALIFORNIA HIGHWAY COMMISSION

RALPH W. BULL, Chairman, Eureka

J. P. BAUMGARTNER, Commissioner, Santa Ana
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HARRY A. ENCELL, Attorney, San Francisco

E. FORREST MITCHELL, Secretary

HEADQUARTERS STAFF, SACRAMENTO

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L. V. CAMPBELL, Office Engineer

FRED J. GRUMM, Engineer of Surveys and Plans

C. S. POPE, Construction Engineer

T. H. DENNIS, Acting Maintenance Engineer

CHAS. E. ANDREW, Bridge Engineer

R. H. STALNAKER, Equipment Engineer

C. L. MCKESSON, Materials and Research Engineer

E. R. HIGGINS, Chief Accountant

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DIVISION

of

CONTRACTS AND RIGHTS OF WAY

C. C. CARLETON, Chief

DIVISION

of

PORTS

Port of Eureka—F. B. Barnum, Surveyor

Port of San Jose—Edgar A. Luca, Surveyor

Port of San Diego—Not yet appointed

DIVISION

of

ARCHITECTURE

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P. T. POAGE, Assistant Architect

W. K. DANIELS, Deputy Chief of Division

HEADQUARTERS

ALFRED EICHLER, Architectural Designer

H. S. HAZEN, Architectural Designer

W. E. MANHART, Architectural Designer

RODERICK MILES, Architectural Designer

HARRY W. DeHAVEN, Chief Architectural Draftsman

C. H. KROMER, Structural Engineer

CARLTON PIERSON, Specification Writer

F. M. STEWART, Principal Clerk

C. E. BERG, Engineer Estimates and Costs

J. W. DUTTON, General Superintendent Construction

W. H. ROCKINGHAM, Mechanical Engineer

W. M. CALLAHAN, Electrical Engineer

A. J. BEAKEY, Civil Engineer

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of

ENGINEERING AND IRRIGATION

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Division of Engineering and Irrigation

J. J. HALEY, JR., Deputy Chief of Division

A. D. EDMONSTON, Water Resources Investigation

R. L. JONES, Bureau of Reclamation

W. A. POST, Santa Ana River Investigations

W. A. PERKINS, Investigation of Dams

S. T. HARDING, Irrigation and Special Investigations
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DIVISION

of

WATER RIGHTS

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EVERETT N. BRYAN, Deputy Chief of Division

KATHERINE A. FEENEY, Chief Clerk

SPENCER BURROUGHS, Attorney

CHARLES KAUPKE, Kings River Water Master

HARLOWE M. STAFFORD,

Sacramento-San Joaquin Water Supervisor

GORDON ZANDER, Adjudication, Water Distribution

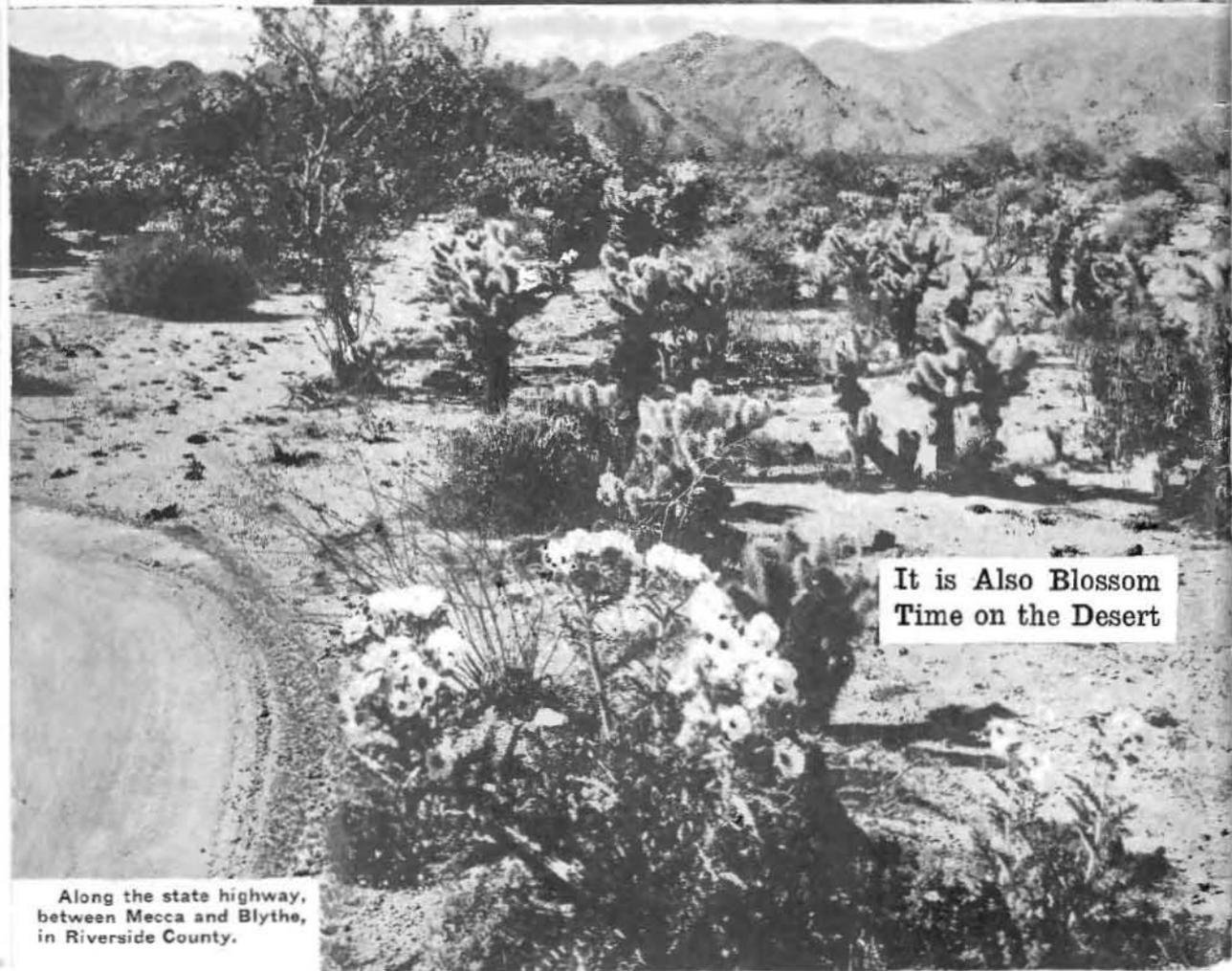
R. H. JAMISON, Ventura County Investigations

Headquarters, 707 Forum Bldg., Sacramento, California

J. H. CLARKE, Auditor, Division of Engineering and
Irrigation, Water Rights and Architecture



Scene between Barstow
and Needles in San Ber-
nardino County.



It is Also Blossom
Time on the Desert

Along the state highway,
between Mecca and Blythe,
in Riverside County.