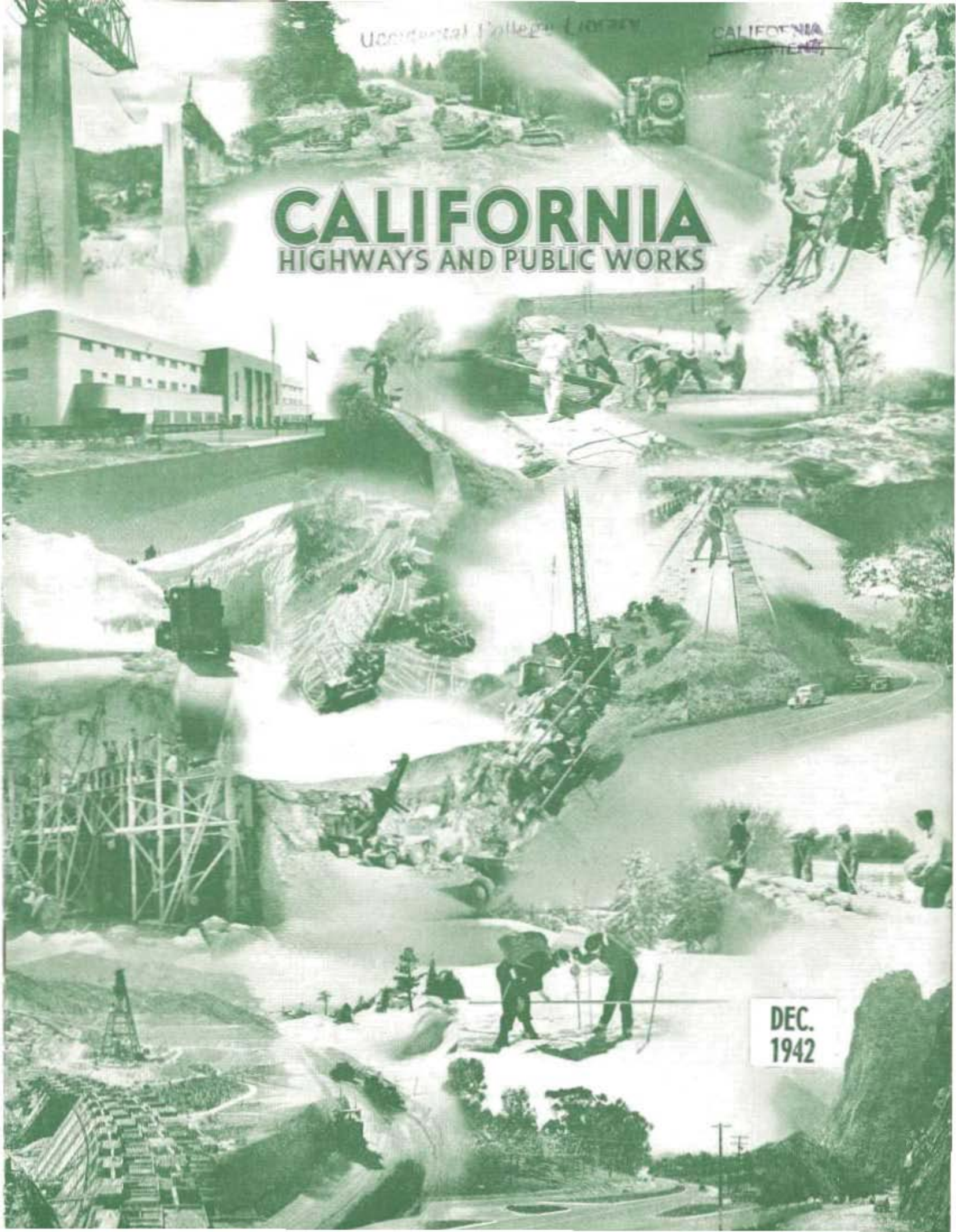

# CALIFORNIA
## HIGHWAYS AND PUBLIC WORKS

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1942

# CALIFORNIA HIGHWAYS AND PUBLIC WORKS

Official Journal of the Division of Highways, Department of Public Works, State of California [PRINTED IN U. S. A.]

FRANK W. CLARK, Director C. H. PURCELL, State Highway Engineer J. W. HOWE, Editor K. C. ADAMS, Associate Editor

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## *Table of Contents*

# $29,425,000 Decrease Estimated in Highway Funds of Next Biennium Due To Rationing and Loss of Federal Aid

DUE to tire and gasoline rationing and the loss of Federal aid funds, California in the next biennial period may be confronted with a shrinkage in State highway revenues approximating as high as 60 per cent, State Highway Engineer C. H. Purcell has informed the California Highway Commission.

Purcell submitted to the Commission an estimate of income for the 95th-96th fiscal years which is $29,425,000 less than the amount in the present budget.

From the indicated decline in traffic and with the benefit of the experience of gas rationing in eastern States, Purcell estimated that within a few months, the now rapidly declining gas tax revenue will be less than last year's by 35 to 50 per cent. The accuracy of these estimates was confirmed by the fact that the October, 1942, gas tax apportionment, which had been predicted would be 15 per cent less than that of October, 1941, amounted to 15.8 per cent less.

**Purcell estimated that the Division of Highways will have for expenditure on State highways outside of incorporated cities the sum of $43,416,500 as compared to $72,841,500 for the same purposes provided for in the current biennial budget.**

### Allocation of Highway Funds Recommended

**The following recommendations for distribution of the 95th-96th fiscal years highway funds were made to the Highway Commission by State Highway Engineer C. H. Purcell:**

| | | |
|---|---|---|
| **Estimated Revenues** | | |
| 1. Gas Tax | $45,134,000 | |
| 2. Motor Vehicle Fees | 7,400,000 | |
| 3. Use Fuel Tax (Diesel) | 2,066,000 | |
| 4. Caravan Fees | 100,000 | |
| 5. Federal Aid | 0 | |
| Total | | $54,700,000 |
| **Allocation** | | |
| 1. Administration | $3,934,250 | |
| 2. Traffic Engineering and Special Investigations | 330,000 | |
| 3. Maintenance | 19,104,000 | |
| General $19,054,000 | | |
| Carquinez & Antioch Bridges 50,000 | | |
| 4. Highway Planning Survey | 200,000 | |
| 5. Major City Streets—¼¢ gas tax allocation | 5,641,750 | |
| 6. City ¼¢ for State Highways | 5,641,750 | |
| 7. All other functions (Reconditioning, resurfacing, improvement, engineering, right of way, joint highway districts, reserve and contingency) | 19,848,250 | |
| | | $54,700,000* |

* Less deduction of $11,283,500 representing ½¢ gas tax allocations to cities.

ESTIMATED REVENUES

Estimated revenues for the next biennium, Purcell reported, will be approximately $54,700,000. Subtracting $5,641,750 of ¼-cent gas tax allocations for major city streets and a like sum for State highways within cities, a total of $11,283,500, will leave $43,416,500 for expenditure by the Division of Highways for administration, construction, maintenance, and all other functions.

During the next biennium the State will be deprived of normal Federal aid funds as represented in the present budget of $7,960,000 of Federal aid, $460,000 for feeder roads and $997,000 for strategic highways.

Purcell pointed out that no large State highway projects can be planned for construction due to restrictions imposed by the Federal Government which prohibit highway construction that is not directly essential to the war effort and which require approval of the Army and the Public Roads Administration for all jobs costing in excess of $1,000. He said that the State will have to confine itself almost entirely to maintenance work and reconditioning of highways damaged by excessive traffic due to war activities.

TRAFFIC COUNTS DECREASE

In a statement Purcell said: "While for the past months and at the present time, the California Division of Highways has been engaged in the enormous construction program for access and defense roads financed almost entirely with Federal funds, the rubber shortage, speed limitation and imminent rationing of gasoline have lessened highway traffic to the point where revenue from the gas tax is definitely on the decrease.

"Traffic counts on the State Highway System for July, 1942, when compared to those of July, 1941, showed an average decrease in total traffic volume of 17.7 per cent with a maximum of 55 per cent decrease recorded on one interstate route.

"At the same time there have been general traffic increases on certain arterials which feed areas of concen-

(Continued on page 9)

Fill slope treatment. Half of seed is sowed before straw is applied

A closer view of strawing operation. Rate of application is 3 tons per acre

# Vegetative Slope Protection on Access Road Cuts and Fills

By L. S. MANNING, Asst. Resident Engineer

THE principles of vegetative protection of highway cut and fill slopes, as outlined in an article by H. D. Bowers in the May, 1942, issue of "California Highways and Public Works" magazine are being applied to seven military access road contracts now underway or recently completed in Monterey County, District V, Division of Highways.

Due to the fact that very little data is available regarding the cost of slope erosion control, an attempt has been made in District V to coordinate this work in relation to other contract operations and to determine the most effective methods to use. Specifications covering the various contracts differed slightly as to the basis of compensation to the Contractor.

### TOPSOIL STRIPPED

All specifications contained the provision that slopes be left in a roughened condition with an allowable variation from the plans of not more than one-half foot.

Wherever preliminary investigation disclosed a likelihood of erosion, topsoil was stripped and stockpiled. This was later spread on slopes to a depth of from three to four inches and was then seeded with western rye grass at the rate of one pound per 300 square feet.

Straw was then applied at the rate of three tons per acre and punched into the soil with shovel. Commercial fertilizer was spread on those cut slopes where, in the judgment of the Engineer, the available topsoil was not sufficiently fertile to support good plant growth.

Fill slope treatment consisted of seeding and applying straw to new fill slopes on three contracts near Castroville. Bid prices for this work were \$0.06, \$0.08 and \$0.10 per square yard, however, actual cost proved to be only about \$0.03 per square yard for the operation.

### PRICE-COST DIFFERENCES

On two contracts, topsoil was stripped, stockpiled, cut slopes roughened and topsoil spread over the slopes; compensation being on the basis of roadway excavation. Slope erosion protection on these contracts consisted only of seeding and applying straw. Bid prices were \$0.08 and \$0.10 per square yard, while actual costs were comparable to fill slope treatment at about \$0.03 per square yard.

On five other contracts an erosion protection item provided for the roughening of cut slopes, the removal of topsoil from stockpiles, drifting topsoil over slopes, the seeding and application of straw. Stripping and stockpiling of topsoil was paid for as roadway excavation.

Bid prices on the Erosion Protection Item were \$0.12, \$0.15, \$0.20 and \$0.30 per square yard. Actual costs, however, have been from \$0.07 to \$0.09 per square yard depending on the amount of hand work required in roughening cut slopes.

Topsoil was imported at those locations where local material was not sufficient to cover the slopes. Bid prices were \$0.70 and \$1.50 per cubic yard, including the loading, hauling, and spreading. Actual costs of this operation are not as yet available. On one contract, where a considerable amount of fill treatment excavation was necessary, the dredged material, rich in humus, was used as topsoil on the thorough-fill slopes and at other locations where the topsoil was insufficient. By this procedure, both of the problems relating to disposal of dredged material and obtaining topsoil for fill slopes were solved.

### METHOD PROCEDURE

In general, the following methods were used:

As excavation progressed, topsoil sufficient to cover the slopes was stockpiled in windrows well away from construction operations. This was accomplished by the use of a motor grader or bulldozer. Small benches parallel to the roadbed were left in the cut slopes by grading equipment, thus providing a roughened surface upon which to place the topsoil.

After oil mix gutters were completed, the top of slopes were rounded, and topsoil removed from windrows by motor grader. This material was then drifted down over the face of the cuts. Hand labor was principally used to rake the soil and complete the cover, although one contractor resorted to a long plank pulled by chains from above and below to move the bulk of topsoil farther down the slope. This resulted in a substantial reduction in labor costs.

Compacted surfaces left by slope rounding operation were loosened with a scarifier, thus preparing the soil for seeding. Slough, which rolled to the gutter during the placement of topsoil was picked up by hand and hauled away.

### STRAW WAS ANCHORED

Bales of straw were placed at the top of slopes, broken up, and passed to a line of men who spread it evenly over the slope area. A second line of men punched or tucked the straw into the loose topsoil with shovels at approximately one foot intervals, the object being to anchor the straw and tie the uncompacted topsoil together. Half of the allotted quantity of seed was sowed before the straw was applied, after which the remainder was placed, in order to insure an even stand of grass.

On all contracts, those areas outside of cut and fill slopes which were subject to erosion were seeded with western rye grass or barley and paid for as extra work. Seed was covered by hand or horse drawn cultivation. Since these projects will be completed during the coming rainy season, it was highly desirable to obtain a quick protective cover, this was accomplished by the application of commercial fertilizer where necessary.

### SOIL LOSSES CONTROLLED

From observations made in District V on experimental plots near Santa Barbara and work on contracts in Monterey County, it is evident that certain modifications in technique may be made, resulting in a lessening of cost to the State for erosion control.

It has been found that a cover of vegetation offers the most practical means of controlling soil losses from highway cut and fill slopes, and that a blanket of topsoil is necessary for the establishment of an effective growth of vegetation. All slopes composed of material which may erode, therefore, should be designed for topsoil cover with provisions for a generous amount to be stripped and stockpiled before excavation. Any excess may generally be used for forming intercepting ditch, berms, or in the development of transitions at the ends of slopes.

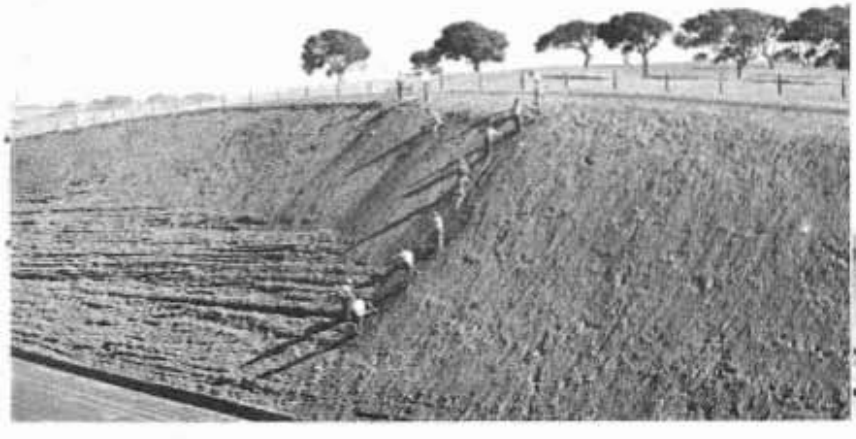
The adequate roughening of cut slopes composed of compacted, or highly impervious material is most important in order to break up the slippage plane which otherwise would exist, resulting in loss of the topsoil layer during winter rains. The excavation of small benches from 4 to 6 inches in depth at intervals of one foot during the progress of construction is a relatively easy matter to accomplish by the use of a bulldozer or blade.

### TOPSOIL APPLICATION

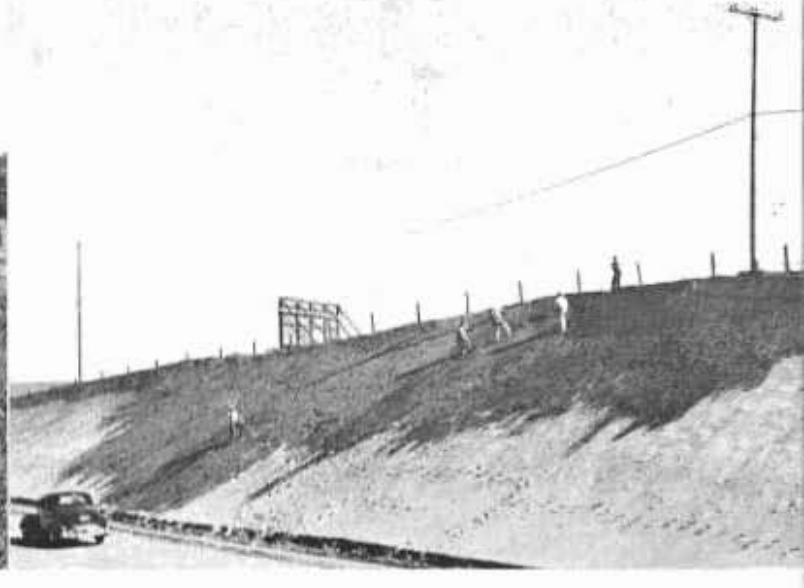
Topsoil should be applied on cut slopes when excavation is approximately one foot above profile grade. At this stage, equipment can be freely used for spreading operations on the slopes, and resulting slough may be disposed of by excavation equipment. Straw should then be applied. This procedure has several distinct advantages, chief among these being that when a project is under construction during the winter or spring months, protection is given to the slopes as soon as they are exposed.

Quite often a growth of vegetation may be obtained a year earlier than if this work were done at a later stage in construction. If application of topsoil is made after the gutter is in, costs are considerably increased due to the necessity for a larger propor-

(Continued on page 20)



Raking top soil down—Improved appearance of cuts after covering would justify this method if no other factors were involved



Raking top soil down unconsolidated sand cut. Tendency toward erosion by wind action already apparent

# Culvert Entrances and Headwalls On California Highway System

ROBERT L. THOMAS, Assistant Engineer—Surveys and Plans
GEORGE A. TILTON, Jr., Assistant Construction Engineer

## Foreword

This is the fourth of a series of 10 articles in this magazine based on a joint departmental review of culvert practice of the California Division of Highways, by a committee composed of R. Robinson Rowe, Assistant Engineer, Bridge Department, Clarence F. Woodin, Assistant Maintenance Engineer, and the writers. Following a preliminary outline in the August issue, the series has included: September issue—"Comparative Hydrology Pertinent to California Culvert Practice"; October issue—"Debris Control at Culvert Entrances on California Highways;" November issue—"Highway Culvert Location and Slope from a Review of California Practice."

The series continues with a consideration of entrance conditions involving headwalls and endwalls and appurtenances and their effect on hydraulic efficiency of the culvert.

FOR the past 30 years of California culvert practice, empirical determination of the size of a culvert opening has been the all-important essential of design. The ability of a culvert to carry drainage water under the highway has been based on the size of entrance opening with too little attention to other hydraulic and installation refinements. This practice, however, has been more or less justified by the fact that run-off records were few and short, so that floods could not be estimated closely. Under such conditions there was little logic in resorting to refinements in hydraulic design.

This practice was no doubt widespread and recognized as such at the time of experiments on the flow of water through culverts in 1926. (1)* It was pointed out that nearly 30 different formulas had been proposed for use in determining the run-off and waterways required for culverts. In practically all of these formulas the area of the waterway is given directly without apparent consideration of the hydraulic gradient, coefficient of roughness or the form of the entrance.

Recognition of the above situation in California has stimulated special designs in the past few years. Inspection and inquiry throughout the State concerning these experimental designs including rounded-lip, belled-lip entrances or transition throats brought out little enlightening data on their performance, probably due to difficulty of inspection at the time of maximum flow.

**With accumulation of longer-period rainfall records by various governmental agencies enabling increasingly accurate determination of the intensity-frequency of run-off and availability of experimental hydraulic culvert data, the time has arrived for adopting design refinements. The proper place to begin these refinements of the culvert proper is at the entrance.**

**Rounding, beveling or expanding the entrance in almost any way will increase capacity of the culvert for every design condition—whether outlet is free or submerged; whether slope is above or below critical; whether 10-year flood just fills the entrance (unbalanced design) or the 100-year flood fills the pipe throughout with head at entrance (balanced design).**

**Under conditions of balanced design and given quantity, the rounded-lip entrance will maintain the same mean velocity at lesser head, the effect of which is to equalize velocity distribution within the section by accelerating the current along the wetted perimeter and reducing concentration at center, thus abating the scour effect at outlet.**

### Rounded-lip and Beveled-lip Entrances

Efficiency of expanded entrances increases with the culvert size and

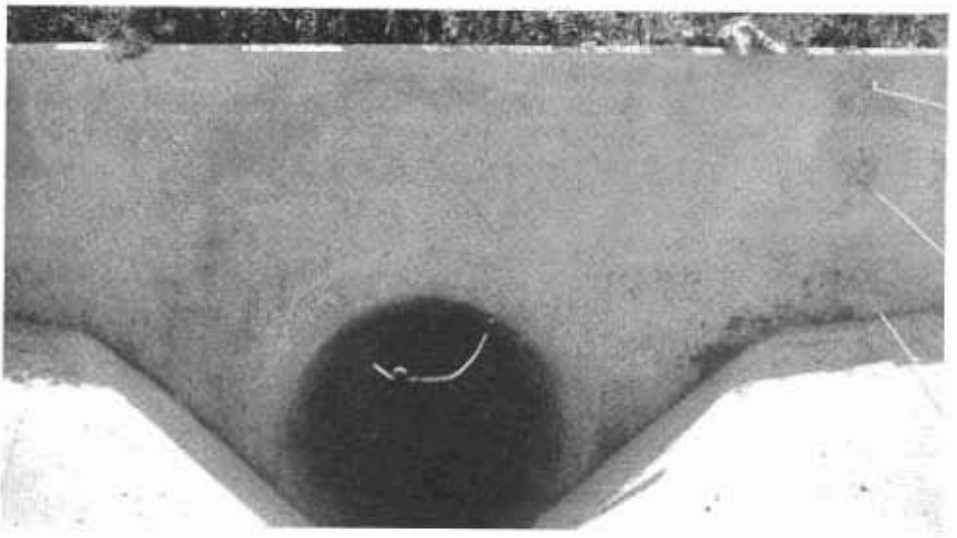


FIG. 17. Concrete pipe with rounded-lip entrance. Note "drop-down" apron to accelerate flow before reaching culvert entrance

* Numbers in parenthesis with asterisk refer to bibliography listed at the end of this article.

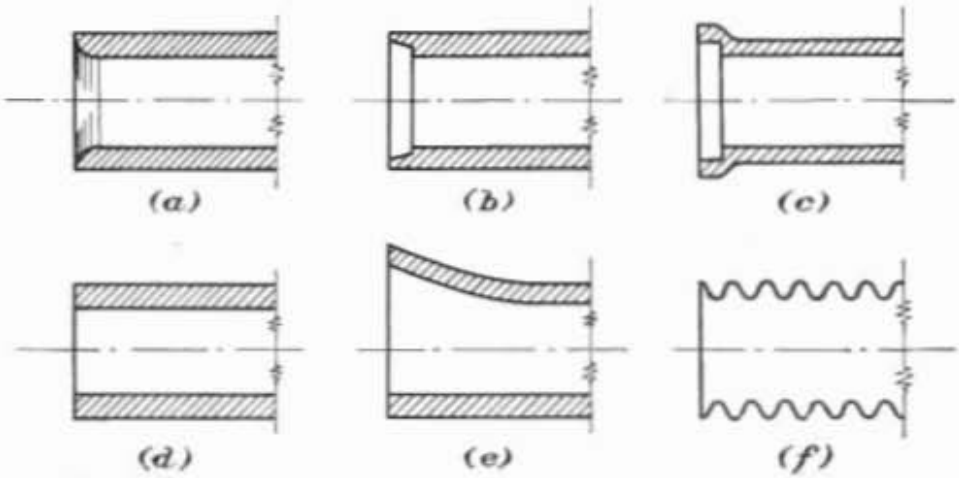



FIG. 18. (a, b, c, d, e, f) Types of Culvert Entrances. (a) Rounded-lip (concrete), (b) Beveled-lip (concrete pipe), (c) Belled-lip (concrete or vitrified pipe), (d) Square-ended (concrete), (e) Belled or throated (concrete), (f) Affected rounded-lip (corrugated metal)

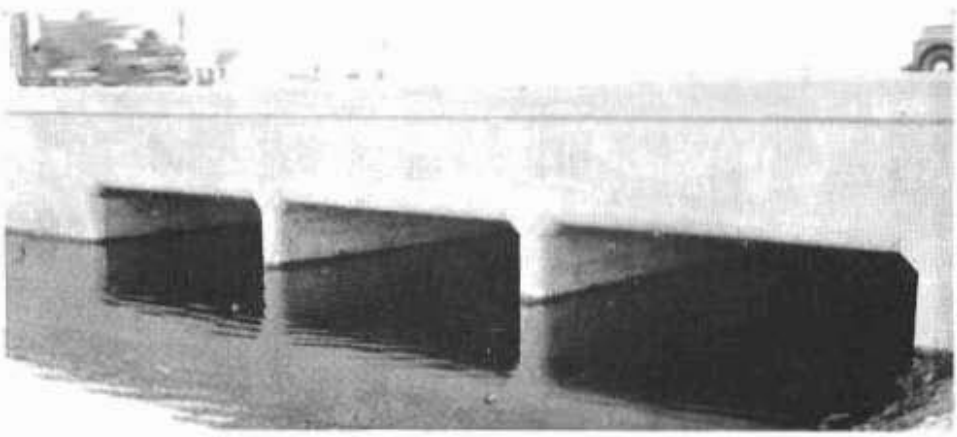


FIG. 19. Rounded-lip entrance to concrete box culvert

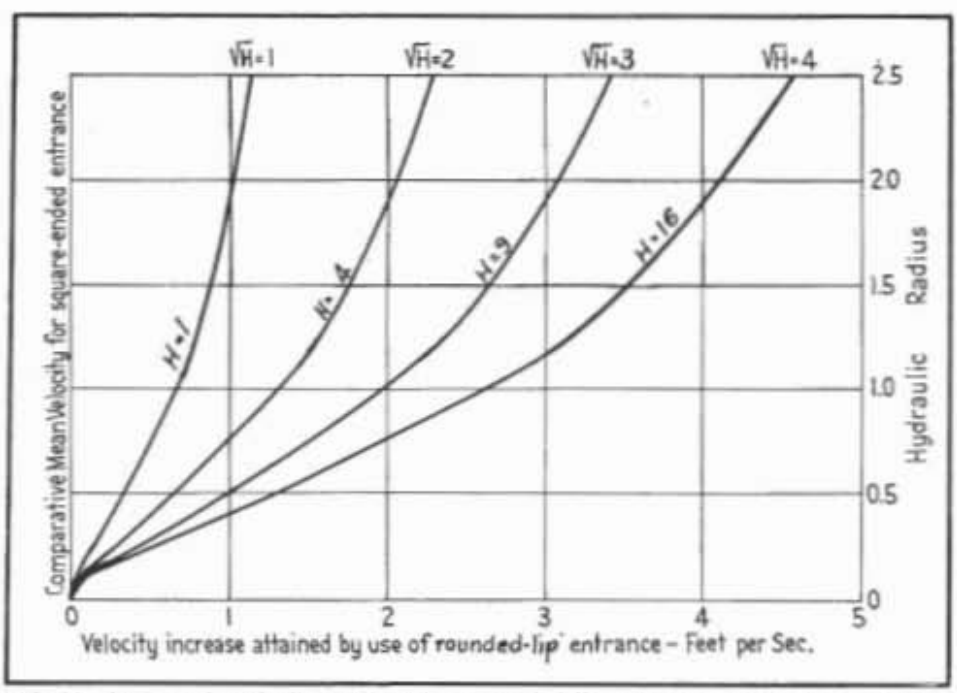



FIG. 21. Increase in velocity attained by a rounded-lip entrance compared to a square-ended entrance. (For culvert 100 feet in length.)

decreases with the culvert length. (See Fig. 18.)

For example, a 39-inch beveled-lip concrete pipe 30 feet long has the same capacity as a 42-inch square-ended concrete pipe; likewise, a 57-inch beveled-lip is equivalent to a 63-inch square-ended pipe. On the other hand, a 51-inch beveled-lip concrete pipe 200 feet long is just equal in capacity to a 54-inch square-ended pipe. Fig. 17 shows a concrete pipe with a rounded-lip which is not recommended—the commercial beveled-lip is considered to be satisfactory.

The saving in entrance loss for concrete pipes is shown briefly in Table 2 in which "E" represents the percentage of total head lost in beveled-lip pipe to that lost in a square-ended pipe of the same diameter. In other words "E" is the efficiency of the square-ended pipe relative to the beveled-lip pipe.

TABLE 2

| Diameter Concrete Pipe | "E" Culvert Length 30′ | 100′ | 200′ |
|---|---|---|---|
| 18″ | 85 | 91 | 94 |
| 48″ | 71 | 75 | 80 |
| 72″ | 64 | 68 | 72 |

The same principle affects concrete box culverts to a greater degree, because the entrance can be rounded to the optimum shape (Fig. 19) whereas it is not practical to require a special rounding of a commercial pipe. Fig. 21 graphically illustrates the velocity increase due to rounding of entrances as compared to square-ended entrance. When the water surface at entrance is below the crown of the culvert, the condition approaches that of a weir and the increase in velocity by use of a rounded-lip is between 5 per cent and 6 per cent.

### Hydraulics Affecting Culvert Entrances

The head required for a culvert has at least four components: (1) Velocity head, (2) Entrance loss, (3) Friction loss, (4) Eddy loss.

The first two are effective at the entrance, unless the culvert becomes a siphon. (Siphons and sag-pipe culverts will be treated in a later article). The elevation of the headwater pool above the crown of the culvert cannot be reduced below their sum. Hence, any saving in entrance loss will be reflected ordinarily in a lowering of headwater pool, which means a decrease in backwater above the culvert.

Experiment (1)* has determined that this saving is independent of culvert length and is proportional to the velocity head, in accordance with the following formulae:

(For concrete pipe culvert) $\blacktriangle h_e = (.31\sqrt{D} - 0.10)h_v$

(For box culvert) $\blacktriangle h_e = (.4\sqrt[10]{R} - 0.05)h_v$

Table 3 gives values for these expressions for several sizes of culverts and three entrance velocities.

**Table 3**

| Culvert Size and Type | Saving in Entrance Loss (head in feet) by Beveled-lip or Rounded-lip over Square-ended Entrance for Velocity of 5 | 10 | 15 |
|---|---|---|---|
| 18" concrete pipe | .11 | .44 | .98 |
| 48" concrete pipe | .20 | .81 | 1.82 |
| 72" concrete pipe | .26 | 1.03 | 2.31 |
| 2'x1.5' concrete box | .10 | .40 | .91 |
| 4'x3' concrete box | .13 | .52 | 1.16 |
| 8'x6' concrete box | .16 | .65 | 1.47 |
| 12'x9' concrete box | .19 | .75 | 1.68 |

**Since use of beveled-lip entrances on concrete pipe or rounded-lip entrances on concrete box culverts will either: (a) Reduce the size of culvert, or (b) reduce materially the back-water caused by the culvert, the Committee recommends:**

**(1) That beveled-lip entrances be adopted as standard practice for concrete pipe and rounded-lip entrances for concrete box culverts, with a radius of rounding equal to approximately 10 per cent of the greatest culvert dimension; and that square-ended entrances be considered as exceptions which need to be justified for either type of culvert.**

**In the case of arch culverts, whether part-circle, multiple, or concrete, rounding of the vertical entrance walls only is recommended. The cost of forming a rounded-lip on the crown portion of a concrete arch will offset any saving in head.**

**Rounding of the concrete headwall to corrugated metal culverts is not recommended since the manufactured product already affects a rounded-entrance.**

### Throated Culvert Entrances

**In special cases where it becomes economical or practical to reduce the culvert section, as in the case of a very long culvert, throated-entrances are justifiable (Fig. 20). To offset the conjectural objection to the throated entrances to culverts in waterways carrying heavy debris, some type of debris control* should be installed to prevent large stumps from entering and choking the throat.**

* See October 1942 issue California Highways and Public Works.

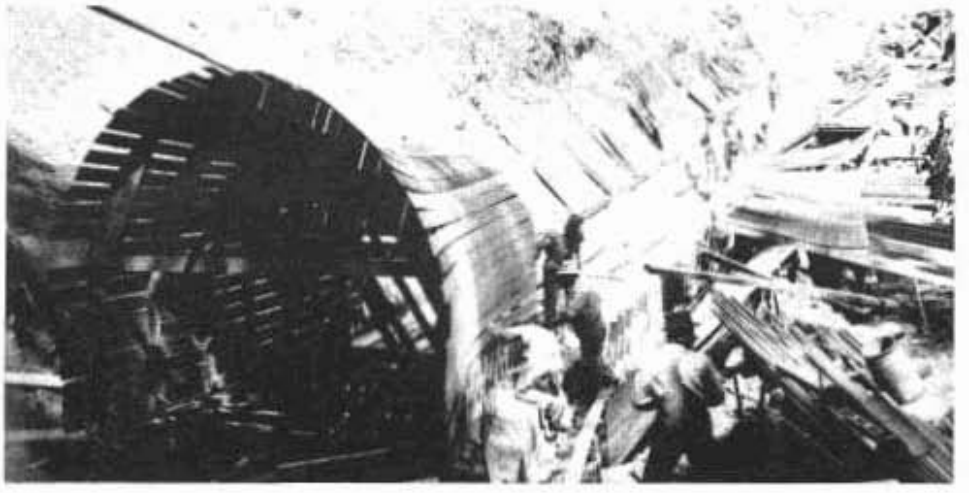


FIG. 20. Forms for throated entrance to concrete arch culvert. Note gradual flattening of grade towards outlet

### CULVERT HEADWALLS AND ENDWALLS. See Fig. 25

Widespread field inspection indicates an arbitrary and nonuniform practice in the selection and adaptation of headwalls and endwalls. The tendency towards selection of the same standardized type for both the headwall on the upstream end and

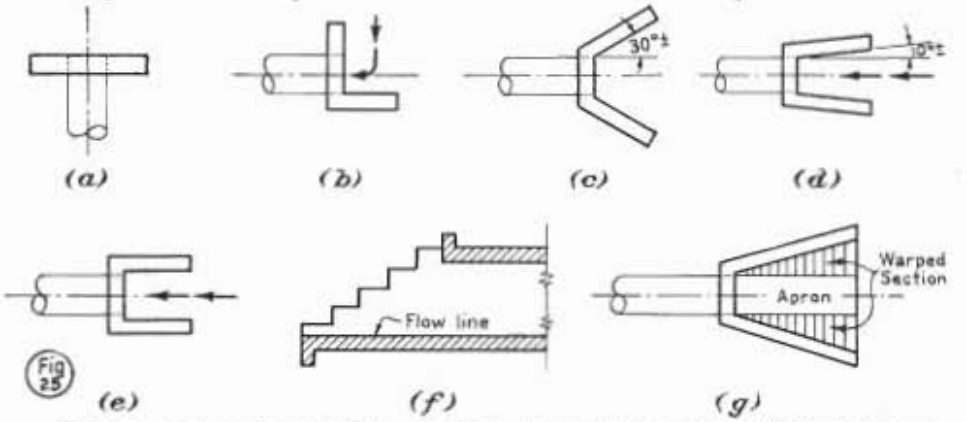



FIG. 25. (a, b, c, d, e, f, g) Types of Endwalls and Headwalls. (a) Straight headwall or endwall, (b) "L" headwall, (c) Wing headwall or wing endwall (30°± flare), (d) Flared headwall (10°± flare), (e) "U" type headwall or endwall, (f) Stepped "U" type headwall or endwall, (g) Warped wingwall or endwall

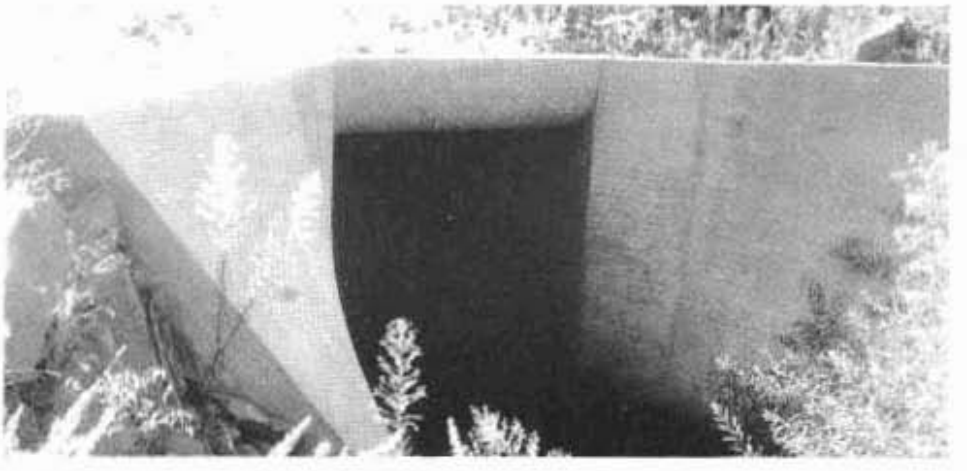


FIG. 22. Warped wing headwall with rounded-lip crown at entrance to concrete box culvert

FIG. 24. Stepped "U" Type Endwall. Most inefficient type—not recommended except for cattlepass where drainage is a minor factor

the endwall on the downstream end in disregard of the different stream flow conditions is evident.

At culvert entrances, wingwalls are frequently given an arbitrary flare of 45 degrees, which generally proves unsatisfactory for high approach velocities or oblique approach flow. Flaring wingwalls from the axes of the approaching stream flow instead of from the culvert axis, is advisable. Warped wing headwalls (Fig. 22) costing little more than vertical wingwalls reduce scour as well as loss of head at the culvert entrance.

When combined with an apron on a drop-down slope from the approach channel, an increase in velocity is induced by the contracting water section such as to materially increase efficiency of the culvert entrance. (Fig. 17.) At the outlet, wing endwalls are often flared to lines that water can not follow at high velocities. This results in scour of embankments from eddy action at the ends of the wingwalls each side of high velocity effluent.

Increased culvert efficiency may be obtained by proper attention to the design and selection of headwalls and endwalls as indicated in the following observations in recent experiments (1)* as follows:

**"The 45 degree wingwalls used in connection with a corrugated metal pipe culvert increase the capacity from 1 to 10 per cent over that obtained in a metal pipe culvert with a straight endwall."**

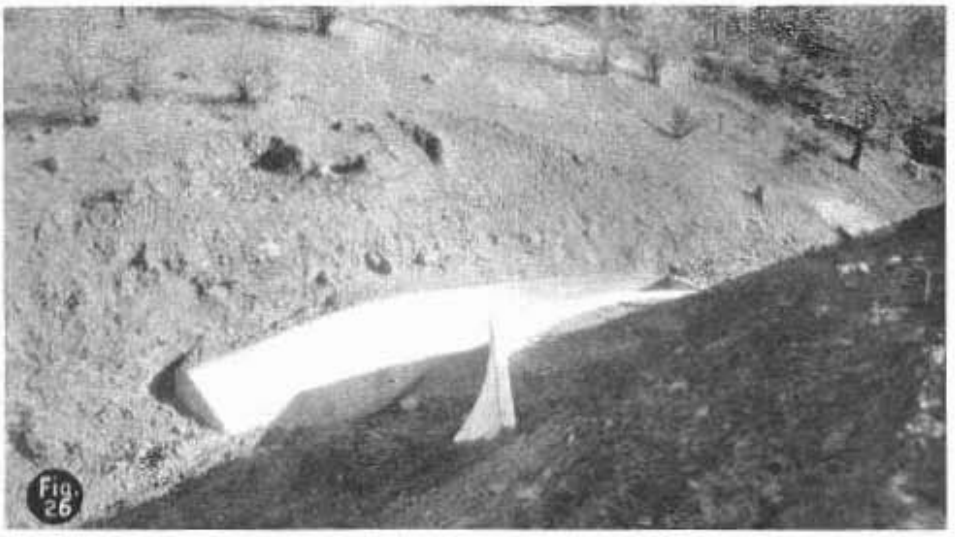


FIG. 26. Open lined training channel to concrete box culvert accelerating stream flow requiring minimum culvert section. Note warped wings

**"The 45 degree wingwalls used in connection with a corrugated metal pipe culvert are more efficient when set flush with the edge of the pipe than when set 6 inches back from the edge of the pipe."**

**"The 45 degree wingwalls used in connection with a corrugated metal pipe culvert are more efficient when built full height to the top of the headwall than when constructed only to the standard height." (Crown of entrance)**

"The 'U' type wingwalls used in connection with a vitrified clay pipe culvert produce a carrying capacity slightly less than that with the straight endwall." (headwall)

## RECOMMENDED ADAPTATION OF HEADWALLS AND ENDWALLS

### Straight Headwall

For low approach velocity or headpool, light floating debris, undefined approach channel; or small defined channel entering culvert without change of direction; or limited right of way, or small culvert near grade.

### Straight Endwall

For low velocity effluent not requiring outlet protection against eddy action.

### "L" Headwall

For gutter drainage (traverse relief culvert) where necessary to abruptly change course of water, natural defined channel where abrupt change of line cannot be avoided.

### Wing Headwall or Wing Endwall

For well-defined channel, moderate velocity, medium drift.

### Warped Wing Headwall (Fig. 22)

For well-defined channel, moderate to high approach flow, medium drift, is considered the most efficient type of practical headwall, streamlining flow by a gradual transition from the wider channel, higher stage and slower velocity of channel flow to a higher velocity at culvert entrance—particularly effective with drop-down apron to accelerate and contract stream flow before it reaches culvert entrance.

### Warped Wing Endwall

For moderate to high velocity discharge, is considered the most effi-

* Numbers in parenthesis with asterisk refer to bibliography listed at the end of this article.

cient type of endwall at outlet because it reduces the drop down curve (free outlet) and minimizes velocity at the end of the apron.

### "U" Headwalls and "U" Endwalls Stepped "U" Headwalls and "U" Endwalls

Most inefficient type of headwall or endwall, insofar as hydraulic considerations are concerned. (1)* Advantage lies in ease and economy of extension. (Fig. 24.)

Recommended only for cattle passes where drainage is a minor factor.

### Flared Headwall

For well defined channel with moderate approach velocity, medium drift, at high velocity, and heavy drift at moderate velocity.

Advantage lies in ability of slightly flared walls to align drift so that it passes the culvert endwise.

### No Endwall

Endwalls are not required at the downstream end of pipe culverts where there is little likelihood of damage from erosion. Cantilever extension of metal pipe are generally cheaper than endwalls. Experiments (1)* indicate that a headwall at the upstream end of a culvert increases entrance efficiency over a culvert with no headwall.

### Miter and Skew End-Cuts For Metal Pipe and Multiplate Culvert

Where culverts are laid oblique to the roadway alignment, miter and skew end-cuts for the sole purpose of fitting embankment slopes or paralleling the roadway centerline are not recommended. (Fig. 28) Uncut projections are not generally unsightly (Fig. 27). Miter cuts make future extensions expensive, saving in cost is negligible, representing little more than scrap value of cut-off; structurally the pipe may be weakened unless mitered end is adequately reinforced with rods. The Committee found no support for the practice of miter or skew cuts.

**Summarizing its findings the Committee recommends generally that:**

**(1) The practice of referring to headwalls and endwalls separately be encouraged in place of the general term of "headwalls" for both upsteam and downstream ends.**

**(2) That headwalls be designed to obtain efficient transition of high velocity flows from natural stream channels to culvert entrances by use of warped wingwalls.**

**(3) That wing walls be flared by protraction from the stream axis instead of the culvert axis.**

**(4) That miter or skew cuts of metal pipe or multiplate culverts be justified by other reasons than cost.**

**(5) That the practice of placing headwalls and endwalls parallel to the highway alignment for the sole reason of appearance be discouraged and that exceptions be justified.**

**(6) That the use of lined open training channels and drop-down aprons be encouraged at culvert entrances for the purpose of accelerating approach flow requiring smaller culvert sections (Fig. 26).**

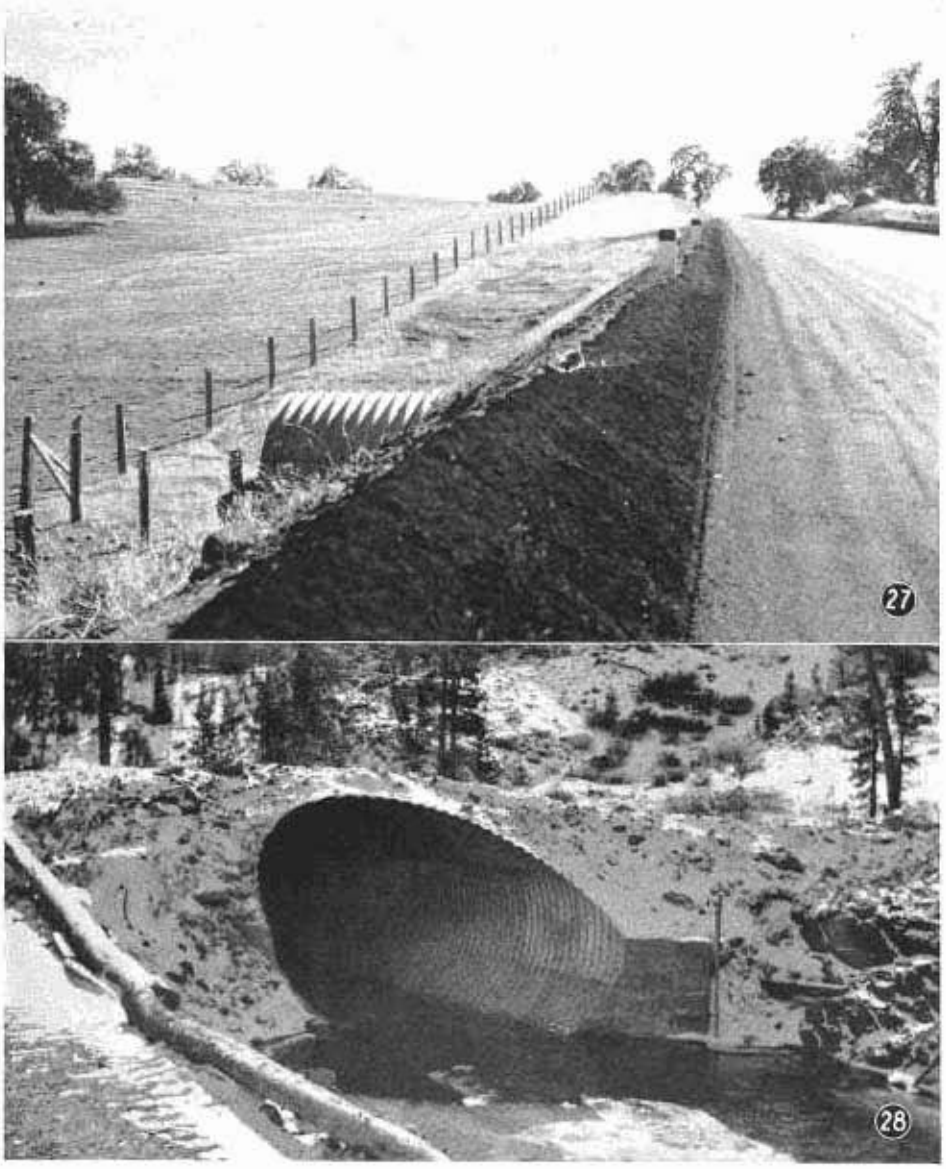



FIG. 27. Multiplate culvert endwall without miter or skew cut—recommended practice

FIG. 28. Entrance to multiplate culvert with skew and miter cut. Committee finds no general justification for either skew or miter cuts for metal pipe or multiplate culvert

Bibliography

(1) Flow of water through culverts. (Bulletin 1, University of Iowa, Studies on Engineering, 1926)

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City miss (to farmer)—"Why are you running that sharp harrow over the grain field? Are you going to raise shredded wheat?"

* Numbers in parenthesis with asterisk refer to bibliography listed at the end of this article.

# $29,425,000 Decrease Estimated in Highway Funds of Next Biennium

(Continued from page 1)

trated industrial activity. One such arterial showed an increase of 14 per cent over a year ago, with the months of April, May and June showing increases of 9 per cent over the first three months of the year. On this route there was an increase in the number of buses from 7,000 in January to over 11,000 in June and in trucks from 24,200 in January to 27,500 in June. On another industrial arterial serving large plants the July, 1942, count was 18 per cent above the July, 1941, count.

"These localized increases, however, are not sufficient to offset the general decline in travel and the corresponding reduction in revenue from the gasoline tax.

CURTAIL MAJOR PROJECTS

"On the basis of the estimated reduction in gas tax revenue, it has been determined that a reduction of $6,500,000 in major projects included in the current budget will be necessary to balance the budget between now and June 30, 1943. This reduction will be accomplished by deferring projects disapproved by the War Production Board as not essential to the progress of the war.

"It must, of course, be understood that elimination of these projects does not mean that the work will be forgotten but that it is merely deferred by the exigencies of the emergency.

"The principal program will be one of maintenance and holding what we have by resurfacing and reconditioning highway surfaces with bituminous blankets and bridge preservation. It is anticipated that if roads essential to the war are to remain in a serviceable condition, resurfacing on some 800 miles at an estimated cost of approximately $7,500,000 must be accomplished as soon as possible.

"General maintenance will be drastically reduced on nearly 2,800 miles of the State Highway System so that essential roads may be kept in service with the limited revenue available. With the practical elimination of the reconstruction program and the concentration of maintenance upon military roads, there is a possibility that the deterioration of considerable portions of the 13,800 miles in the State system will be such that it might require an increase in statutory maintenance limitations to repair the damage resulting from the lack of proper maintenance. It is our aim to pass through the present period with no change in the law which limits maintenance expenditures. The probable highway deterioration will, however, present a most serious handicap after the war when the State will be confronted with the necessity of a large construction program during the readjustment period.

"The problem confronting the Division of Highways is the most serious in California road history and resolves itself into four principal factors: inadequate finances, lack of equipment and materials, and greatly reduced man-power. Solution of this four-fold problem will be accomplished to the best of our ability, with the one idea always in mind that serving the war effort is of first importance and by adoption of a four-fold policy of operation during the emergency. This policy will include: first, maintenance and reconditioning of highway surfaces in serviceable conditions; second, upkeep of bridge structures to present standards; third, preparation of plans for needed highway construction during the period of adjustment after the war; and lastly, insuring the integrity of highway development already begun by acquisition of adequate rights of way for the planned improvements.

The Federal Public Roads Administration has been and continues to be of real service to the Division of Highways in securing the assignment of ratings and it is felt that conditions will improve as the War Production Board comes to an understanding of the relationship of all phases of the work.

## Division Recommended for North and South

Recommended distribution by Highway Commission of 95th-96th Fiscal Years State Highway Funds between North and South is as follows:

| | Allocation of (6) All Other Functions | |
|---|---|---|
| 1. Primary North 54.24% of 50% | $6,912,888 | |
| 2. Primary South 45.76% of 50% | 5,832,112 | |
| Total PRIMARY | | $12,745,000 |
| 3. Secondary North 50% of 50% | $6,372,500 | |
| 4. Secondary South 50% of 50% | 6,372,500 | |
| Total SECONDARY | | $12,745,000 |
| Grand Total | | $25,490,000 |
| 1. Primary NORTH | $6,912,888 | |
| 3. Secondary NORTH | 6,372,500 | |
| Total NORTH | | $13,285,388 |
| 2. Primary SOUTH | $5,832,112 | |
| 4. Secondary SOUTH | 6,372,500 | |
| Total SOUTH | | $12,204,612 |
| Grand Total | | $25,490,000 |

## Construction Decline in 1943

A decline of one-third in the volume of construction in 1943 was forecast by Stacy May, Director of Statistics Division, War Production Board. This estimate was revealed to the American Institute of Steel Construction in a telegram.

"It is expected that the volume of building and engineering construction, exclusive of ship building, scheduled for the War Program in 1943 will drop by more than a third.

"Because of this reduction of volume and because of the use of methods which economize on steel, it is expected that the volume of fabricated structural steel which will be required for building and engineering construction, exclusive of ship building in 1943, is substantially less than was had this year, and will amount to not over a million and a quarter tons."

# Report on Highway Maintenance Equipment and Rental Procedure

By T. H. DENNIS, Maintenance Engineer

**The following article is the first installment of a condensed report of the Sub-Committee on Highway Maintenance Equipment appointed by the Highway Research Board in 1940 to make a specific study of various types of equipment available or in use in performing highway maintenance work with a view to recommending the most suitable and practicable equipment for specific maintenance operations and the establishment of uniform equipment rental procedure throughout the United States. The report represents two years' work by the sub-committee members, T. H. Dennis, Chairman; A. A. Anderson, Portland Cement Association; H. K. Bishop, Chief of Construction, Public Roads Administration; B. E. Gray, Chief Engineer, Asphalt Institute; J. E. Lawrence, State Highway Maintenance Engineer, Massachusetts; Rex M. Whitton, State Highway Maintenance Engineer, Missouri, and was presented at the recent convention of the Board at Detroit. The pictures shown illustrate type of equipment only and the type is not restricted to any particular product.**

TO facilitate the study and permit the placing of each piece of equipment under its proper function, the subject of highway maintenance was divided into eight major categories as follows:

1. **Maintenance of traveled way**
2. **Maintenance of shoulders**
3. **Maintenance of roadsides**
4. **Maintenance of bridges**
5. **Maintenance of miscellaneous structures**
6. **Snow removal, drift and ice control**
7. **Maintenance of trees, shrubbery and plantings**
8. **Maintenance of safety devices**

This outline was submitted to all State Highway Departments, the Public Roads Administration, the Asphalt Institute and the Portland Cement Association, a total of 62 organizations.

Response from the various organizations contacted was very good. Reports of equipment used in maintenance work were received from 34 States and from all 12 Public Roads Administration Districts. The information submitted was not complete in all cases, but was representative and reflected a majority practice.

It was expected that the varied climatic conditions encountered throughout the United States would develop special requirements in maintenance and thereby produce special features in the equipment used. Hence the States, as well as the various Public Roads Administration Districts, were grouped by areas of similar climatic conditions to permit summarization of the data on that basis.

## Equipment Rental

FORTY-ONE States responded to a questionnaire on equipment rental which was submitted to them by the Highway Research Board. The majority opinion of the reporting agencies generally reflected the subcommittee's opinion. The replies, however, definitely argued against the possibility of any general acceptance of a uniform rental system. A summary of the replies to each of the items included in the questionnaire and the subcommittee's recommendations follow:

**Item 1. (A)** Is the present method of handling equipment satisfactory?

**(B)** Are any changes contemplated in the present system?

The majority of States reporting considered present methods of handling equipment satisfactory and none contemplated changing present methods. It would thus appear that promotion of a uniform rental system will be difficult.

**Item 2.** Does the State Highway Department perform all maintenance work on State Highways, or is all or a portion let to contract to other political subdivisions or private contractors?

(Continued on next page)

### Basis of Selection

Upon receipt of data from the various organizations, every piece of equipment used by them was listed in its proper category on tabulation sheets. The equipment as recommended by each of the subcommittee members for each maintenance operation was also entered on the tabulation and their recommendation was considered equal to that of any State or Public Roads Administration District.

Obviously all of the recommendations received did not merit consideration for inclusion in the final tabulation. It was agreed, therefore, that a choice of approximately 10 per cent of the reporting agencies would be required to qualify a unit for inclusion in the final recommendation. Under this procedure the recommendation of any five of the reporting agencies was taken as the minimum requirement for the selection of a particular unit.

This method obviously eliminated certain special nonstandard or obsolete types which some organizations found it expedient or necessary to use under their particular local conditions.

The equipment selected for any specific type of work, therefore, represented the majority recommendation of the reporting agencies. In general the recommendations were remarkably consistent, the principal variance being in size or capacity.

A study of the principal types reported indicates the following gen-

eral trend as to use and also the scope of work for which the unit is particularly suited.

### Discs

The light disc harrow and scarifier is used to some extent in certain areas in the construction and maintenance of intermediate oil type surfaces. This limited use is due either to a preponderance of high type surface or the employment of mixing plants. The scarifier attachment on motor graders and tow graders is responsible for the declining use of the separate unit. The motor grader disc attachment is adaptable for removing irregularities on bituminous type surfaces.

FIGURE 1

The light disc harrow should be of the offset type with heat treated discs and each disc equipped with a scraper and positive pressure type lubrication fittings. The frame should be adjustable so that the gangs may be operated at opposing angles. A short coupled tractor hitch should be provided.

The weight of harrow should not be less than 2,000 pounds and the width approximately 8 feet. The discs should be from 18 inches to 24 inches in diameter spaced on about 10-inch centers.

FIGURE 2

The disc attachment for use on motor graders may be attached to either the front or rear of the moldboard (figures 2 and 3 respectively).

The discs should be alloy steel, heat treated, and mounted on a square axle with self-aligning dust-proof thrust bearings on each end. Suitable steel collars, or other arrangements should be provided for holding the bearings and keeping the discs tightly on the shaft.

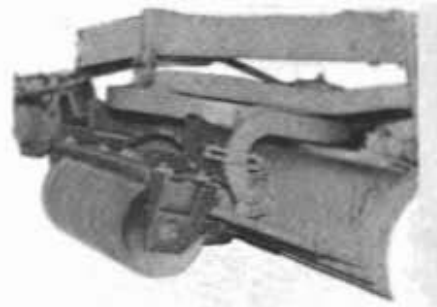

FIGURE 3

The weight of the attachment should not be less than 1,200 pounds and the width approximately 48 inches. The disc should be approximately 20 inches in diameter and spaced on 2-inch centers.

FIGURE 4

The road type disc scarifier assembly should consist of two rows of discs (four gangs), with a minimum of seven discs per section and should be mounted on a four wheel pneumatic-tired low type trailer with steel frame approximately 16 feet long and 4½ feet wide.

The unit should weigh approximately 7,000 pounds. The discs should be approximately 20 inches in diameter and operated with a hydraulic power lift or equivalent apparatus for setting and adjusting the cutting depth.

### Distributors

Truck mounted oil distributors of 800 to 1200 gallon capacity are best suited for general maintenance oiling operations. The capacity is sufficient for a day's work with a small crew and if a greater quantity of oil is required, the truck is powered to tow a tank trailer of equal capacity. On smaller jobs the 300 to 600 gallon trailer distributors are preferred. These latter units are easily towed by a one and one-half to two ton truck.

The distributors described are also suitable, when equipped with special spray bars, for applying diesel oil or other liquid agents to roadside vegetation.

Since oiling operations are seasonal, the distributor unit (especially the truck mounted type)

## Equipment Rental

(Continued from preceding page)

The information obtained indicates that some portion of all maintenance on State highways is carried out by day labor forces in 42 States, while 14 States report that certain phases of maintenance work are let to contract. General practice, therefore, dictates that maintenance of highways should be performed by day labor forces and that special work be let to contract wherever such work is beyond the capacity of these forces and the items of special work can be readily defined.

**Item 3.** Does the State own all equipment used on maintenance work or is a portion of the equipment rented from outside parties?

Equipment used on State highway maintenance is, in general, State-owned. It is common practice, however, to rent privately-owned equipment such as power shovels, oil distributors, heavy trucks, etc., for seasonal or emergency work. The purchase of State-owned equipment is usually confined to units required continuously or to special types not readily available on a rental basis. Such a policy is of mutual benefit both to the State and the private equipment owner since it avoids the necessity of a heavy capital investment by the State, and provides work for privately owned equipment which might otherwise be idle.

The recommendations received indicate that all equipment required for normal maintenance operations should be owned by the supervising authority and that outside equipment be rented for special or emergency use.

AVERAGE EXPENDITURES

**Item 4.** What is the average annual expenditure for rental of State-owned equipment, and for equipment rented from outside parties?

The average annual expenditure for rental of equipment

(Continued on next page)

should be designed for easy removal from the truck chassis.

FIGURE 5

Bituminous distributors having a capacity of from 300 to 600 gallons should be mounted on a two-wheel pneumatic-tired trailer. The tank should be elliptical in shape, electrically welded, and so constructed as to permit low center of gravity.

The tank should be equipped with a manhole opening of ample size, thermometer well, an overflow pipe and a discharge opening at the rear of tank with piping so arranged as to permit the following:

1. Fill tank through pump from drums or spray tank.
2. Circulate material in the tank while heating without passing through the spray bar.
3. Spraying from tank through hand spray bar.
4. Drain pump and pipe lines without draining the tank.

The unit should be equipped with at least two sets of 6 inch U-type return heating flues made of heat resisting tubing and located in the lower half of the tank. The heating unit should include the following items:

1. Two removable kerosene burners located in the end of tank shielded so that the flame will not contact the end of the flue.
2. Automatic fuel pump for kerosene with pressure relief valve and by-pass.
3. Fuel tank of at least 20 gallon capacity with a filler cap and automatic air relief. The tank should be located away from the burners, preferably at the opposite end of the bituminous tank.

A rotary type pump, powered with an air cooled gasoline engine, should be so

FIGURE 6

arranged that the material can circulate when the valves are closed. The pump should be enclosed in a removable sheet steel housing which will permit heating by return flue gases from the burners or engine exhaust.

The spray bar should be at least 1½ inches in diameter and not less than 4 feet long, fitted with slot type spray nozzle which will produce a suitable fan shaped spray. Fifteen feet of 1 inch diameter heat resisting hose, complete with pipe extension handle and cut-off valve and nozzle, should be provided for hand spraying.

A platform should be provided at the rear so located that the operator can control all operations.

## Equipment Rental

(Continued from preceding page)

owned by the 26 States reporting was $1,383,270 per State. An additional amount equal to 21 per cent of this average was likewise expended for the rental of privately owned equipment. This latter figure serves to emphasize the dependence now placed on that source.

**Item 5.** Is State-owned equipment handled by a separate department, by the maintenance department or by the districts?

It was found from the replies that support for each method of equipment administration is about equally divided. Some of the advantages as well as the disadvantages of each method are enumerated;

Under an equipment engineer with special training there should be greater assurance of the performance of mechanical features, the enforcement of necessary working restrictions and insistence on timely upkeep and repairs. On the other hand, this centralization of authority unless accompanied by a knowledge of maintenance problems and operations might well handicap a maintenance organization.

ADMINISTRATION

Administration under a district would of course permit the selection of equipment best suited to its particular conditions and insure its coordinated use. However, under such administration there is always the likelihood of over-equipping or concentrating on specialized equipment. Furthermore, the exigencies and demands of particular work might well overrule practical considerations of upkeep and repair.

Many of the disadvantages of the district method apply equally well to administration by a maintenance engineer. His major concern naturally is the performance of work, generally with a contractor's viewpoint regarding the use of the equipment but without the latter's opportunity

(Continued on next page)

FIGURE 7

Bituminous distributors having a capacity of from 800 to 1,200 gallons should be constructed with steel skids suitable for truck mounting.

The tank should be oval in shape of at least 10 gauge steel, electrically welded, properly insulated and lagged. The tank should be equipped with a manhole opening of ample size, thermometer well, overflow pipe, clean-out opening in the bottom and baffle plates of sufficient size and number to prevent excessive surge. Thermometer well shall be adequately insulated from heating flues.

The distributor should be equipped with at least two sets of 6 inch U-type return heating flues made of heat resisting tubing, located in the lower half of the tank. The heating unit should include the following items:

1. Two removable kerosene burners located in the end of tank shielded so that the flame will not contact the end of the flues.
2. Automatic fuel pump for kerosene with pressure relief valve and by-pass.
3. Fuel tank of at least 50 gallon capacity with filler cap and automatic air relief. The tank should be located away from the burners, preferably at the opposite end of the bituminous tank.

The pump should be a positive displacement type located on a base inside of the tank with the drive shaft extending through the shell. The drive shaft should be supported by self-aligning bearings with stuffing box located outside of the tank. The pump should be powered with a water cooled gasoline engine having not less than four cylinders and capable of applying two gallons of bituminous material per square yard for a width of 10 feet at stated truck speeds. The complete pump assembly should be so arranged as to be readily removed from the tank.

The piping and valves should be of ample size to convey the material without undue friction loss and provided with sufficient valves arranged to permit cutting out the boot, pumping from either end of the tank, inside suction to outside discharge and outside suction to outside discharge. All swing joints should be of the ball bearing type.

The spreader boot should be full circulating lateral swing type of ample size to convey the material to the sprays without excessive pressure or injury to the pump, and should be approximately 8 feet long with a 2-foot, full circulating, separately controlled extension on each side allowing for a 12-foot spread.

The sprays should be double tip, with single valve, and spaced on about 6-inch centers. Flexible metal hose and hand spray assembly should be provided. A separate lever to control each 4-foot section of boot, a lever control for each boot extension, and a hand wheel or crank for raising or lowering the boot assembly should be provided.

The platform should be located so that the operator can reach all controls, as well as the engine pump and operating valves, without moving from the platform.

### Tank Car Heaters and Retorts

The two-car capacity two-wheel trailer mounted steam heater is preferred for the lower viscosity liquid asphalts where deliveries are taken from tank cars or storage. In localities where severe winter prevails, the heater may also be used for thawing out culverts or frost boils.

The retort heater, four wheel trailer type, is used for the heavier grades of liquid and paving asphalts required in armor coat, seal coat and retread surfaces. The unit, however, was not recommended by the Atlantic or New England group of States, where apparently heating requirements are handled by either stationary plants or field kettles.

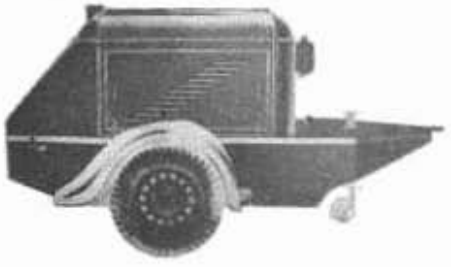

FIGURE 8

The tank car heater should be two-car capacity and capable of heating an uninsulated tank car of bituminous material to a temperature of at least 200 degrees F. within a reasonable time. It should be mounted on a two-wheel pneumatic-tired trailer.

## Equipment Rental

(Continued from preceding page)

of writing off the investment at the conclusion of the job. Then too, the purchase of equipment, its repair and upkeep is a specialized job for which the maintenance engineer is seldom trained. He is, however, conversant with the demands of his work and therefore better versed in setting up the control features of the equipment required.

Because of the equal popularity of the three methods of administration, the views of the committee members were taken as the deciding factor. Of the five committee members who expressed a preference, three favored a separate department and two considered the administration of equipment matters should be under the maintenance department.

RENTAL SYSTEM

**Item 6.** Is State-owned equipment handled on a rental basis?

State-owned equipment is handled on a rental basis in 75 per cent of the States reporting on this question.

Two desirable objectives are reached through use of a rental system. First, it permits creation of a reserve fund from which to finance the cost of repair and replacement of maintenance equipment. Second, the cost of equipment is distributed currently against the work on an equitable and reasonably accurate basis. In addition there is a decided advantage in having a basis of comparison as to cost of operation of equipment in the several districts which normally make up a State highway organization. The information is desirable also if a comparison is to be made between the cost to the State of owning and operating equipment as against the cost of renting privately owned and operated equipment. There would be a further benefit from an administrative point of view, if the policies and rental rates in the

(Continued on next page)

The boiler should be the return, condensate, horizontal type, fully insulated and lagged and equipped with an injector and steam trap. It should be capable of developing from 25 to 40 H.P. under a working pressure of 125 to 135 pounds per square inch. The heating unit should be internal combustion type using fuel oil burners. The fuel tank should have sufficient capacity to operate five hours under maximum load.

FIGURE 9

The retort booster heater should be mounted on a four-wheel pneumatic-tired trailer. It should have a BTU output of 1,750,000 units per hour, and designed

FIGURE 10

so as to provide a heating capacity equal to the following based on one passage of the asphalt through the unit:

40° F. temperature increase at 164 G.P.M. pumping rate.

90° F. temperature increase at 80 G.P.M. pumping rate.

190° F. temperature increase at 40 G.P.M. pumping rate

Heating should be accomplished by passing the bituminous material over and around the tubes which receive the flame and hot gases from the oil burners. The heating system should be so arranged that the hot gases pass in a downward direction before being exhausted through the stack. The bituminous material should be pumped into the tank at the bottom and out at the top with a reversible type pump. The maximum capacity of the pump should not be less than 165 gallons of fluid asphalt per minute. It should be jacketed and so designed that

it can be heated by the engine exhaust or other means, and powered with at least a four cylinder radiator cooled gasoline engine.

The pumping unit should have two speeds in one direction and one in reverse, and equipped with a three-way valve to provide distribution and by-pass facilities.

The oil burners should be adjustable and provided with suitable connections to permit removal for cleaning and repair. They should be designed to burn fuel oil up to and including 28-30 Baumé gravity.

The tank should be fitted with flow-equalizing mechanism to insure uniform circulation of the oil. The tube assembly through which the burner heat passes should be designed to provide for expansion and contraction.

### Asphalt Heating Kettles

The asphalt heating kettles from 165 to 300 gallon capacity on two-wheel trailers are the size most widely used on all types of surfaces other than untreated earth or gravel. They have sufficient capacity for normal daily maintenance requirements and can be readily towed by light trucks.

The 300 to 550 gallon capacity, two wheel trailer type kettle, is not a popular choice and its use (mainly by certain Central States) is confined to bituminous plant mixed surfacing. It is noted that in States where these units are used, there is no recommendation for oil distributors.

FIGURE 11

FIGURE 12

| | | | |
|---|---|---|---|
| CAPACITY: Approximate gallons | 165 | 210 | 300 |
| WEIGHT: Minimum pounds | 1,300 | 1,500 | 2,700 |
| HEIGHT: Loading, approx. inches | 46 | 50 | 50 |

## Equipment Rental

(Continued from preceding page)

various States were calculated on a basis which would permit comparisons.

**Item 7.** What method is used for figuring depreciation?

Replies to this question indicate that it is the general practice to establish depreciation rates on a straight line basis with due consideration to first-cost and trade-in values. Only one State reported a varying rate from year to year for units in a given group. One State reported original purchase is from special appropriation and one State reported that entire cost is depreciated in the year of purchase.

#### COST OF EQUIPMENT

It is possible that legal requirements in some States make it mandatory to secure special appropriations for purchase of equipment. However it should be noted that the true cost of work can not be ascertained if the cost of equipment is not distributed in some manner.

Allowance for depreciation is based on the service life of the equipment and the salvage value at the time of retirement. The service life of each unit in a group of similar equipment units is dependent on (1) the number of hours of operation and the severity of work performed within the given period, (2) indeterminate items such as the skill of operators or care in servicing and (3) the policy followed by different States as to repairs and/or replacements. The question of time of replacement has a special significance. It is the policy in some cases to replace units before extensive overhaul is necessary. Obsolescence as well as changes in traffic requirements or improvement of the road system may effect changes in equipment needs and thus limit the period of usefulness of certain units. All these factors must be considered in establishing depreciation rates. There

(Continued on next page)

The asphalt heating kettle should be mounted on a two-wheel pneumatic-tired trailer so designed as to afford a low center of gravity. The heating unit should consist of a fire box, outside shell and removable blow torch, and should have a melting capacity of at least 1,000 pounds of asphalt per hour. The tires and fuel tank should be protected from the heat. The fuel tank should have a capacity of not less than 20 gallons and should be of welded construction throughout and designed to withstand a maximum pressure of 60 pounds per square inch. The pump should be gear type, submerged or with other provision for heating, and powered with a suitable air-cooled gasoline engine. Provision should be made for two hand spray hose connections, and a barrel hoist complete with chain blocks should be included.

### Loaders

The belt type loader mounted on two pneumatic tires is generally favored. Two other types of belt loaders are worthy of special mention—one is attached to a motor grader, the other is a self-propelled pneumatic-tired unit with force feed. Second choice is the bucket type loader. The pneumatic-tire mounting is preferred over the track-laying type for the latter unit.

The tractor mount front-end bucket loader has its supporters for loading from stockpiles and slide removal work. It is available for mounting on both the wheel and track-laying type tractors.

FIGURE 13

The belt loader, Figure 13, should be the "Trough" type with rollers spaced not more than 36 inches apart. The belt should be equipped with carrying cleats properly spaced for handling river or creek bed gravel. The cleat length should not interfere with proper troughing. Provision for take-up should be made at the upper end roller. The conveyor should be chain driven with a radiator cooled gasoline engine located above the belt.

The loader should be approximately 26 feet long and have approximately 12 foot clearance at the discharge. The unit should be mounted on two pneumatic-tired wheels.

The belt loader attachment for motor grader, Figure 14, should be the "Trough"

type with rollers properly spaced to prevent sag. The belt should be approximately 30 inches wide with provision for take-up at the upper end roller. The unit should be constructed so that the material is forced onto the belt by means of positive force feed mechanism capable of loading at least 60 cubic yards of windrowed material per hour. A discharge height of at least 7 feet is required.

FIGURE 14

The digging depth should be hydraulically controlled with levers located in the cab of the motor grader. The complete attachment will weigh approximately 4,000 pounds.

FIGURE 15

The travel type belt loader, Figure 15, should be the "Trough" type with rollers properly spaced to prevent sag. The belt should be approximately 30 inches wide with provision for take-up at the upper end roller. The unit should be so constructed that the material is forced onto the belt by means of positive force feed mechanism. The unit should be capable of loading material from a windrow or stockpile at the rate of at least 60 cubic yards per hour. The discharge height should be approximately 9 feet.

FIGURE 16

The unit should be self-propelled, mounted on two axles and equipped with pneumatic tires. It should be capable of traveling 25 miles per hour when in transit. The unit complete will weigh approximately 10,000 pounds.

The bucket loader should be powered with at least a four-cylinder gasoline engine and equipped with a two-speed transmission. A feeding worm or device should be provided which will draw the material to the buckets from a width approximating the tread of the loader. The loader should have a capacity of not less than 1½ cubic yards per minute. A swivel belt conveyor approximately 8 feet in length with a clearance of approximately 12 feet should be provided.

The loader should be mounted on pneumatic-tired wheels and should weigh not less than 7,200 pounds and not more than 10,000 pounds.

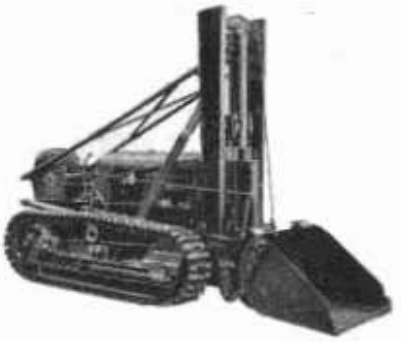

FIGURE 17

FIGURE 18

The tractor front-end loader, Figures 17-18, should have a capacity of from ½ to 1 cubic yard and should be mounted on not less than a 30 H.P. tractor, either wheel or track-laying type. The hoist and frame should be located forward of the tractor radiator. The bucket or scoop should have a replaceable cutting edge and should be designed so that it may be dumped at any desired height up to 7 feet. The unit may be either mechanically (cable) or hydraulically operated. All control levers should be within easy reach of the operator.

On track laying type tractors where the shovel attachment exceeds ¾ cubic yard capacity, the tracks should be extended to provide proper balance. A special heavy spring, and wider front axle to provide clearance, will be required on wheel tractor installations.

(Continued in an ensuing issue)

## Equipment Rental

(Continued from preceding page)

are also varying emergency conditions. For example, the life of highway maintenance equipment now in service will no doubt be prolonged through more intensive overhauls and replacement of worn parts as a result of the war emergency.

REPAIR AND UPKEEP

**Item 8.** List the items included in the rental rates for State-owned equipment (operating costs, operating supplies, repair, upkeep, depreciation, overhead, profit, etc.)

The majority of States reported that rental rates include depreciation, cost of repairs, upkeep and all operating costs except wages of the operator. There is practically universal agreement that the wages of the operator should be excluded from equipment rental rates.

In arriving at the cost of repair and upkeep, the following overhead items should be taken into account in addition to depreciation and gradual obsolescence:

1. Major repair, overhaul and upkeep.
2. Storage, insurance, incidentals and equipment overhead.
3. Cost of plant including land, shop buildings and power machine tools.
4. Cost of operating (fuel and lubricants) and servicing costs.

If comparisons are to be made with rental rates charged for outside or privately owned equipment, the following items should be given consideration:

1. Interest on investment or profit.
2. Insurance and surety bond premium.
3. Taxes.
4. Wages of operators.

(Continued in an ensuing issue)

# Division of Water Resources Saves 288,800 Miles With Tire Usage Plan

THROUGH a program of tire conservation developed and put into operation by the Division of Water Resources a saving of more than 288,800 miles in passenger car and truck travel has been effected by the division thus far this year.

In a report to Director of Public Works Frank W. Clark on the results of the program to October 1st, State Engineer Edward Hyatt shows that the budget of conserved automobile mileage prepared by the division earlier this year, which proposed to reduce the 1942 automobile use 45 per cent under that of 1941 is not only being met but bettered.

The division has in use 55 passenger cars and eight trucks. Much of its work is of such a nature that automobile transportation is the only means of covering its wide field of activities. This includes supervision of dams, operation and maintenance of the Sacramento Flood Control Project, water master service, snow surveys, stream gaging, flood control and hydraulic construction and special investigations and inspections, all of which necessitate field work in nearly every county of the State. A considerable portion of this field work is located in mountainous or sparsely populated areas not served by bus or trains.

### MILEAGE SAVING

Last year was a normal one for division activities. No additional or unusual duties were pursued during the year. Although various rules for conservation of cars were in effect and division cars were used only from a pool, 755,408 passenger car miles and 76,583 truck miles, or a total of 831,991 car miles were traveled in carrying on these activities.

Activities of the division for 1942 were budgeted to 396,700 passenger car miles and 60,000 truck miles, of which 193,832 passenger car miles and 35,000 truck miles were budgeted for the first half of the year.

In spite of the radically reduced mileage proposed by the division to meet emergency conditions, as of October 1, 1942, actual travel in division cars was only 338,188 miles against a budgeted allowance of 351,000 miles. This is 12,812 miles under the budgeted allowance and is particularly impressive when compared to 1941 during which division cars had traveled 627,000 miles up to October 1. It represents a saving in 1942 of 288,812 car miles.

In addition to car and tire conservation reduced travel represented a saving of $14,440 in car travel at 5¢ a mile. This amount, however, is not a complete saving as much of the business which otherwise would have been conducted by actual contact was done through use of telephone, telegraph and letters.

### TIRE CONSERVATION

The tire conservation program of the division was developed shortly after declaration of war by the United States. A thorough review and analysis were undertaken of all the activities of the division to determine where automobile travel could be eliminated or reduced without actual neglect of those duties imposed on the division by various statutes. This survey was designed to:

1. Economize in all possible ways during the emergency.
2. Make automobiles and personnel available for any extraordinary duties in connection with the war and national defense.
3. Conserve automobiles and tires.

At that time the State Engineer issued instructions to functional supervisors covering the prolonging of life of tires by careful operation, speed limitations and restrictions of the use of automobiles by eliminating travel where results could be obtained through correspondence, telephone or telegraph and utilizating trains or buses wherever such means of transportation were available.

The supervisors also were instructed to prepare reports on activities and possible curtailment of automobile use. A committee was appointed to prepare a tire inventory and draft instructions for use of the division's motor vehicles and assist in assembling activity curtailment reports.

### TIRE INVENTORY

An estimate was made of the mileage available from the tires on hand. The general formula used was based on an average life of 17,000 miles on past use of tires. On the basis of rigid tire conservation according to previous instructions it was estimated the future average tire life would be 25,000 miles. Mileage run on tires up to the time of the inventory was subtracted from 17,000 and the remainder multiplied by 25/17 to arrive at the estimated remaining mileage.

The estimated combined car mileage available at the time of the inventory for the 55 passenger cars was 891,000 car miles or an average of 16,000 miles per car. Total mileage for the 8 trucks was 186,000 car miles or an average of 26,500. For the 63 passenger cars and trucks total estimated rubber on hand was 1,077,000 car miles or an average of 17,095.

On the basis of this inventory the division budgeted its mileage in such a manner that the average use of cars without replacement in rubber would last until July, 1944. Due to the fact that a portion of 1942 had passed before severe curtailment of travel was placed in effect, the budget for 1942 is larger than that anticipated for 1943.

Various State and Federal regulations concerning reduced speed limitations and care of tires which have been promulgated since the division's conservation program has been placed in effect are assisting in carrying out the purposes of the program. Gas rationing which became effective December 1st also will have its effect upon the program. On the basis of present results, however, even without these additional items, the program of tire conservation developed and put into operation by the Division of Water Resources will provide it with rubber on a curtailed basis sufficient to carry out its statutory duties through July, 1944, when it is anticipated some relief from the pressing rubber problem will be attained through raw or synthetic rubber.

# Highway Snow Removal Operations Curtailed by War Emergency Needs

SNOW sports enthusiasts will feel the effect of the war this winter.

Maintenance Engineer T. H. Dennis of the Division of Highways has announced that many recreational roads in mountain areas heretofore kept clear of snow in Winter will be closed to traffic until next Spring in order that highways vitally essential to the war effort may be kept open.

Such routes as U. S. 50 crossing Echo Summit to Lake Tahoe, the Wawona entrance to Yosemite National Park, State Sign Routes 44 and 89 leading into Lassen Volcanic National Park, the roads north and south of Tahoe City and the General Grant Kings Canyon National Park highway are embraced in instructions eliminating them from snow removal operations issued to all District Highway Engineers. Many other mountain roads are affected.

U. S. 50 will be closed from Kyburz to Lake Valley at the foot of Echo Summit on the east side. Mr. Dennis said the order will not isolate any communities in the Lake Tahoe area as the Highway Department of the State of Nevada has promised to keep the roads from Nevada into Lake Valley cleared of snow for Winter recreationists.

NECESSARY WAR MEASURE

"Much as the Division of Highways regrets to take this action," Dennis said, "it is absolutely necessary in order to conserve our snow removal equipment for the duration. Much of this equipment is from eight to 12 years old, breakdowns are sure to occur and we do not have the priorities which would enable us to obtain spare parts and replacements for our trucks, push plows, and rotary snow plows. Furthermore, we are confronted with a growing problem of man-power and face a shortage in skilled operators of snow removal equipment."

Dennis said that the Army insists that U. S. 40, the Donner Summit route, be kept open constantly. For this reason, equipment that normally would be used on U. S. 50 will have to be kept instantly available on Donner Summit for use in case equipment there breaks down.

"We can not afford," he said, "to operate snow plows on U. S. 50 and other mountain highways and then be compelled to remove this equipment on a moments notice, leaving recreationists stalled on partially cleared roads during a storm. We would only jeopardize lives and the war effort by doing so.

"Due to the impossibility of obtaining replacement parts and equipment it will be necessary to hold snow removal equipment formerly used on certain routes as stand-by units in the event of breakdown of units now engaged in removal of snow on roads more essential to the war effort. The War Production Board has informed us it will not approve any replacement parts except for equipment used on roads directly essential to the conduct of the war.

"We are unable to obtain priorities necessary for obtaining parts or metal for making repairs and during storms such delays would close roads unless standby units were available."

Many communities in mountain areas, Dennis declared, have been warned that it may become necessary to discontinue snow removal at any time. When this occurs, signs will be placed at both ends of roads leading to these communities reading "SNOW NOT REMOVED BEYOND THIS POINT."

Among other roads listed by Dennis for closing under the snow removal ban are: State Sign Route 89 from its junction with the Susanville Road to Greenville; State Sign Route 138 leading to Big Pines Park in Los Angeles County and State Route 190 leading to Camp Angeles in San Bernardino County; the Big Trees Highway in Calaveras County, closed at White Pines; Sonora Pass Highway closed at Long Barn. State Sign Route 20 east of Nevada City, closed at Washington Road.

Other roads which may be closed if serious breakdowns occur to equipment now on roads essential to the war effort, are: Route 20, Weaverville to Redding; Route 82, Etna Mills to Montague; Route 83, Sierra County line to Blairsden; Route 35, Hayford to Douglas City; and Route 28, Junction of Route 73 to Cedarville.

Snow removal operations in the Lake Arrowhead district of San Bernardino County will be maintained, Dennis said, owing to the fact that several thousand all-year residents in that area must be served.

## England Organizes Planning Officers for Post-War Development

**On July 1, 1942, most of the planning powers and duties of the Ministry of Health were transferred to the Ministry of Works and Planning, which thus becomes the central authority for town and country planning in England and Wales.**

**"The object of the Government's policy is to secure the right use of the land of the country for all purposes. The Ministry has accordingly been charged with the task of guiding the formulation by local authorities in England and Wales of town and country planning schemes which will adequately reflect the national policy for urban and rural development. . . .**

**"In order to facilitate collaboration with local authorities, the Minister will appoint Planning Officers, with headquarters at convenient centers, who will be available to help and advise them. Each of these officers will keep the Minister informed of the problems of the authorities in his area, and will keep the authorities informed of the requirements of national policy as it is developed."**

Arrow points to tunnel No. 1 under construction through ridge of Mt. Williamson on Angeles Crest Highway in San Gabriel Mountains

# Angeles Crest Highway Construction Stopped as Unessential to War Effort

COMPLETION of the Angeles Crest Highway, State Route 61, through the San Gabriel range of the Sierra Madre Mountains will have to wait until after the war. All work on this project has been stopped by order of the War Production Board for the reason that it is a purely recreational road and not essential to the war effort.

The Angeles Crest Highway was being built jointly by the United States Public Roads Administration and the California Division of Highways. The new route begins at the Foothill Boulevard and La Canada in Los Angeles County, extends up the Arroyo Seco and passes through the San Gabriel Mountains to an easterly terminus in Camp Angeles at Big Pines.

Passing Buckhorn Flats, the new highway will serve the Pasadena public camp grounds. The shortest present traveled distance from Los Angeles to Big Pines is 107 miles. The distance by the Angeles Crest Highway will be approximately 64 miles, with a saving of 43 miles.

Grading and surfacing of the route from La Canada to Cedar Springs, a distance of 37 miles, and 24.28 miles of the highway extension from Red Box to Tunnel No. 1, had been completed when the order to cease construction was issued.

This project is notable from an engineering standpoint by reason of the necessity for boring two tunnels, one 675 feet and one 474 feet in length through solid rock. On the section between Cedar Springs and West Islip Saddle, there is very little soil and 80 percent of the excavation must be blasted. Two inclined ridges projecting from the face of Mt. Williamson are so steep as to make tunnels necessary. Three of the four portal locations are on nearly perpendicular rock faces, 50 to 75 feet above the canyon floor.

From West Islip Saddle, the new highway will run along the northerly side of Mt. Islip and North Baldy Peak at elevations of from 6,500 to 7,500 feet above sea level.

To avoid the building of construction roads necessary to by-pass the tunnel sites for roadway work ahead,

Arrow points to pilot trail for proposed continuation of route across slope of Mt. Williamson

a rather difficult job of tunnel boring was undertaken. Beginning at the westerly portal of Tunnel No. 1, a small pilot drift 9 feet wide by 10 feet high, was rapidly excavated at the crown of the tunnel—this size opening being sufficient to pass air equipment and crews ahead for work on Tunnel No. 2.

Excavation was then immediately started on Tunnel No. 2 with a 14-foot by 14-foot pilot drift at grade, this size being adequate for passing heavy grading equipment. Simultaneously with the start of construction of this pilot drift in Tunnel No. 2, excavation of the full face of Tunnel No. 1 was launched and both operations progressed at the same time.

West Islip Saddle, which will be a land mark on the new highway, also will be the northerly terminus of San Gabriel Canyon road, Route 62 from Azusa on Foothill Boulevard to a point four miles beyond Crystal Lake.

Several branch roads have been completed and are in use.

Equipment widening tunnel No. 1 bore. No. 2 bore entrance is seen in background

# Highway Bids and Awards for November, 1942

ALAMEDA COUNTY—At the Distribution Structure, a radio transmitter system, consisting of the erection of a guyed tower, and the construction and/or installation of foundations, radial ground system, transmission lines, auxiliary power plant, and various appurtenances thereto. District IV, Route 69, Section Oak. Underground Construction Co., Oakland, $8,385. Contract awarded to Cogar Bros., Los Angeles, $3,065.

CONTRA COSTA COUNTY—Between one-quarter mile west of Orinda Junction and 1.75 miles west of Lafayette, about 2.1 miles to be graded and paved with portland cement concrete and asphalt concrete on crusher run base. District IV, Route 75, Section A. Contract awarded to Chas. L. Harney, San Francisco, $437,494.

FRESNO COUNTY—At the intersection of Fresno Street and Shields Avenue, approximately 3 miles north of the business district of Fresno, a timber bridge to be constructed across Herndon Canal, approaches thereto to be graded and surfaced with plant-mixed surfacing. District VI. Trewhitt-Shields & Fisher, Fresno, $24,492; M. E. Whitney, Bakersfield, $26,434. Contract awarded to George E. France, Visalia, $23,966.

KERN AND LOS ANGELES COUNTIES—Between Antelope School and Route 58, about 16.1 miles to be graded and bituminous surface treatment applied. District IX, Clyde W. Wood, Inc., Los Angeles, $162,635; Peter L. Ferry & Son, Glendale, $215,922. Contract awarded to Griffith Co., Los Angeles, $141,168.

KINGS COUNTY—Between 1.2 miles north of 5th Standard Parallel and Stratford, about 3.4 miles to be graded and surfaced with road-mixed surfacing. District VI, Route 125, Section D. Louis Biasotti & Son, Stockton, $166,601; George E. France, Visalia, $173,863; Piazza & Huntley, San Jose, $178,113; Brown, Doko & Baun, Pismo Beach, $183,851. Contract awarded to W. C. Railing, Redwood City, $159,145.

LOS ANGELES COUNTY—Between 2 miles north of traffic circle and Lakewood Village, about 0.6 mile to be widened with asphalt concrete pavement and portland cement concrete base. District VII, Route 168,178, Sections A,A. Contract awarded to Vido Kovacevich, South Gate, $29,122.

LOS ANGELES COUNTY—On Redondo Boulevard between El Segundo Boulevard and 116th Street, and between Century Boulevard and Manchester Avenue, about 2.0 miles to be graded and surfaced with plant-mixed surfacing. District VII. Oswald Bros., Los Angeles, $85,775. Contract awarded to Vido Kovacevich, South Gate, $82,077.

LOS ANGELES COUNTY—On Lakewood Boulevard; at South Street, Artesia Avenue, Center Street, Compton Boulevard, and Imperial Highway; traffic signal systems to be furnished and installed. District VII, Route 168, Section A. C. D. Draucker Co., Los Angeles, $32,200. Contract awarded to Econolite Corp., Los Angeles, $31,102.

SAN DIEGO COUNTY—At intersections of Harbor Drive with 32nd Street, 28th Street and Pacific Highway, traffic signal systems to be furnished and installed. District XI, Harbor Drive South. C. D. Draucker Co., Los Angeles, $24,416. Contract awarded to Econolite Corp., Los Angeles, $19,823.

SAN DIEGO COUNTY—At intersections of Rosecrans St. with Lytton St., Midway Drive & Frontier St., and at Mission Valley Road and Taylor Street, traffic signal systems to be furnished and installed. District XI. C. D. Draucker Co., Los Angeles, $42,430. Contract awarded to Econolite Corp., Los Angeles, $37,679.

SAN DIEGO COUNTY—On Harbor Drive in the city of San Diego, over Switzer Canyon Creek and the tracks of the Atchison, Topeka and Santa Fe Railway, an overhead crossing to be constructed. District XI. J. E. Haddock, Ltd., Pasadena, $363,530; Trewhitt-Shields & Fisher, Fresno, $373,671; V. R. Dennis Construction Co., San Diego, $374,866; E. E. Smith, El Cerrito, $392,235; Carlo Bongiovanni, Los Angeles, $394,553; The Contracting Engineers Co., Los Angeles, $411,565; Ralph A. Bell, San Marino, $433,891; United Concrete Pipe Corp., Los Angeles, $444,145. Contract awarded to M. H. Golden Construction Co., San Diego, $329,332.

SAN DIEGO COUNTY—Widening a bridge in the city of San Diego about 4 miles north of the Civic Center across San Diego River. District XI, Route 2, Section S.D. V. R. Dennis Construction Co., San Diego, $63,937; Bent Construction Co., Los Angeles, $65,773. Contract awarded to Contracting Engineers Co., Los Angeles, $41,945.

SAN DIEGO COUNTY—In the city of San Diego, at Rosecrans and Hugo Streets, a traffic signal system to be furnished and installed. District XI. C. D. Draucker Co., Los Angeles, $6,221. Contract awarded to Econolite Corp., Los Angeles, $5,793.

SAN FRANCISCO CITY AND COUNTY—on Third Street, between Custer Avenue and Twenty-third Street and between Mariposa Street and Fourth Street, about 1.3 miles to be graded and paved with asphalt concrete on portland cement concrete and crusher run base. District IV. The Fay Improvement Company, San Francisco, $319,038. Contract awarded to Chas. L. Harney, San Francisco, $283,853.

SAN JOAQUIN COUNTY—Washington Street & Fresno Avenue, between San Joaquin River and Route 75, about 2.6 miles to be graded and surfaced with plant-mix on cement treated base. District X. Elmer J. Warner, Stockton, $128,733; M. J. B. Construction Co., Stockton, $133,578. Contract awarded to A. Teichert & Son., Inc., Sacramento, $120,140.

SAN JOAQUIN COUNTY—JX Road and Lathrop Road, between State Highway Route 5 and Durham Ferry Road, about 2.4 miles to be graded and surfaced with plant-mixed surfacing on C.T.B. and on earth subgrade and bituminous surface treatment to be applied. District X. Elmer J. Warner, Stockton, $84,453; Fredrickson & Watson Construction Co. Fredrickson Bros., Oakland, $87,533; M.J.B. Construction Co., Stockton, $88,122. Contract awarded to Louis Biasotti & Son, Stockton, $78,686.

SANTA BARBARA COUNTY—Between Casmalia and Santa Maria, about 13.0 miles to be graded and surfaced with plant-mixed base. District V, Camp Cooke. N. M. Ball Sons, Berkeley, $725,395; Clyde W. Wood, Inc., Los Angeles, $891,099; Bressi & Bevanda Constructors, Inc., Los Angeles, $1,116,011. Contract awarded to Fredrickson & Watson Construction Co. Fredrickson Bros., Oakland, $701,495.

SOLANO COUNTY—At Benicia, on Fifth Street and on "H" Street about 1.1 miles to be graded and surfaced with plant-mixed surfacing. District X. Chas. L. Harney, San Francisco, $63,953. Contract awarded to Fredrickson & Watson Construction Co. Fredrickson Bros., Oakland, $52,344.

SOLANO COUNTY—Solano Avenue between Fourth Street in Vallejo and Route 7, about 1.3 miles to be graded and surfaced with plant-mixed surfacing. District X. A. G. Raisch, San Francisco, $66,098; E. A. Forde, San Anselmo, $66,475. Contract awarded to Chas. L. Harney, San Francisco, $65,132.

SOLANO COUNTY—Near Vallejo, Sacramento Street, between Route 208 and Frisbie Street, about 0.9 mile to be graded and surfaced with plant-mixed surfacing. District X. A. G. Raisch, San Francisco, $41,420; Chas. L. Harney, San Francisco, $43,948. Contract awarded to E. A. Forde, San Anselmo, $41,128.

# Vegetative Slope Protection on Access Road Cuts and Fills

(Continued from page 3)

tion of hand labor in raking down the topsoil and picking up the slough.

The interests of both the contractor and the State would probably best be served by including in Roadway Excavation, the work of slope roughening, stripping, stockpiling and spreading topsoil. The Slope Erosion Protection item would then include only seeding and application of straw. Recent experiments indicate that with certain heavy types of topsoil an effective growth of vegetation may be secured by seeding alone. Where this type of soil occurs the straw blanket should be dispensed with. Seeding in this event could be performed as extra work.

Straw applied at the rate of three tons per acre covers the slope rather sparsely. A rate of four tons per acre would appear to be preferable.

Attention has been given on all these contracts to the shape of intercepting ditches. As may be observed on older sections of highway, a sharp V type ditch is an invitation to trouble.

The resulting erosion, cuts into unfertile soil which is unfavorable to vegetation.

It has been found both by our own experience and the Soil Conservation Service, that a ditch with a broad rounded cross section covered with topsoil is most suitable for the control of runoff water and the elimination of erosion.

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"Who was our first President?" asked the American lawyer, hoping to test the intelligence of a witness.

"Washington," replied the witness.

"Right! And who was our second President?"

"John Adams."

"Correct!"

There was a pause.

"He's doing fine," whispered a friend of the lawyer. "Why don't you keep on?"

"I'm not sure who was the third myself!"

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9-39



# CALIFORNIA STATE HIGHWAY SYSTEM

SCALE IN MILES
0 50 100

~ LEGEND ~
Primary Routes
Secondary Routes
Proposed Routes

SAN FRANCISCO AND VICINITY

LOS ANGELES AND VICINITY

PACIFIC OCEAN