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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

A
REPORT
on
OBSERVATION OF UNDERDRAIN REHABILITATION
on
I-Men-1-D,E
Between
4.1 MILES N. OF FORSYTHE CREEK AND RIDGEWOOD SUMMIT

57-25

October 7, 1957

MATERIALS & RESEARCH DEPARTMENT
SAGACITAS · SCIENTIA · STUDIUM

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State of California
Department of Public Works
Division of Highways
Materials and Research Department

October 7, 1957

I-Men-1-D,E
Lab P.A. No. 2196-S-20

Mr. Sam Helwer
District Engineer
Division of Highways
Eureka, California

Dear Sir:

Submitted for your consideration is:

REPORT

on

OBSERVATION OF UNDERDRAIN REHABILITATION

on

ROUTE 1

between

4.1 MILES NORTH OF FORSYTHE CREEK

AND RIDGEWOOD SUMMIT

Study made by.....Foundation Section
Under general direction of.....A. W. Root
Work supervised by.....T. W. Smith
Report prepared by.....W. F. Kleiman
A. L. Franks

Very truly yours,

F. N. Hveem
Materials & Research Engr.

Attach
cc:JWTrask
MHarris
JALegarra
Dist. Const. Engr.
BCWalker
Res. Engr.

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Introduction

Prior to the start of Contract No. 58-1TC12, I-Men-1-D,E between 4.5 miles north of Forsythe Creek and Ridgewood Summit, Mr. C. P. Sweet and Mr. A. W. Root had agreed that a representative of the Materials and Research Department would be on the job to observe the rehabilitation of the underdrains.

The underdrains were installed as a part of Contract 53-1TC12-F which was completed August 9, 1954, and the paving was completed November 19, 1954, under Contract 54-1TC18. The roadway consists of a four-lane all paved section, surfaced with 3 inches of plant mixed surfacing over 6 inches of Class "A" cement treated base with a pervious subbase of 9 inches to 15 inches.

During the winter of 1954-1955 it was noted by various personnel concerned that water was flowing through the pavement at various locations and various forms of distress became visible on the roadway.

On May 17, 1955, Mr. W. R. Lovering, District Materials Engineer, made an inspection of the failed areas. In his letter to Mr. Alan S. Hart dated May 20, 1955, Mr. Lovering recommended that headquarters laboratory be requested to investigate the failed areas. A preliminary field investigation was made on June 7 to June 10, 1955, by Mr. Lovering and Messrs. Charles Clawson and Don Smith of this department. As a result of this investigation Mr. Lovering, in a letter to Mr. Alan S. Hart dated June 13, 1955, recommended that the headquarters laboratory make a complete investigation of failed and unfailed areas in both cut and fill. Mr. Hart requested the investigation in letters dated May 31, 1955, and June 17, 1955. The results of this complete investigation, conducted by the Materials and Research Department, were submitted in a report entitled "An Investigation of the Causes of Distress Appearing in a Bituminous Surfaced Road in Mendocino County," Lab. W.O. 39-S-3041, dated January 13, 1956.

"Preliminary Report of Proposed Construction on State Highway Route 1 in Mendocino County between 4.5 miles north of Forsythe Creek and Ridgewood Summit from Sta. 'D' 200+60 to Sta. 'E' 420+30, Mile 3.796 'D' to Mile 1.114 'E', I-Men-1-D,E," dated January 28, 1957, proposed the rehabilitation of these underdrains and the installation of 3250 lineal feet of new underdrains.

Resumé of Construction

The rehabilitation of the existing underdrains consisted of cutting through the PMS and the CTB and excavating through the pervious subbase and the earth seal on top of the underdrain. This earth seal had been placed during the original construction between the pervious subbase and the underdrains.

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At 25 foot intervals holes were dug to the perforated metal pipe to determine the grade of the pipe and the condition of the perforations and the filter material. There were considerable variations as to the amount of filter material removed and amount of pipe replaced depending on the existing condition of the underdrain. The underdrain was backfilled with filter material to a depth within nine inches of the final surface, and paved with six inches of Class "B" concrete and three inches of plant mix surfacing.

On the installation of the new underdrains, the trench was dug a minimum of two and one-half feet or six inches below the pervious gravel base. The perforated metal pipe was placed on top of three inches of filter material in the bottom of the trench. The underdrain was then completed in the same manner as were the rehabilitated underdrains.

Effectiveness of Underdrains Before Rehabilitation

During the rehabilitation of the underdrains, it was found that the underdrains below the earth seal were functioning, but a lot of the seepage in the cut slopes did not get to the underdrain. There were sufficient locations found where water was flowing over the earth seal into the structural section to indicate that considerable subsurface water was flowing at a depth of one foot to three feet below cut faces and entered the structural section above the earth seal. See Photos Nos. 1, 2, 3, 4, 5, 6. Water in the subbase may be the result of percolation of surface water through the PMS and CTB. The earth seal, between the filter material and the pervious subbase (the subbase extending the full width of the roadway) prevents the water in the pervious subbase from entering the underdrain.

Where cutoff drains were installed between cut and fill areas, an earth seal was placed above the filter material. This clay seal prevented the water that was flowing through the structural section from entering the underdrain.

The filter material that was used in the underdrains in Contract No. 53-1TC12-F was a river-run sand and gravel. The material was quite dense at the time of the rehabilitation operations and grading tests on four samples of the old filter material taken from the trenches showed 6% to 8% passing the No. 200 sieve. The Special Provisions called for 0 - 5% passing the No. 200 sieve, Chart No. 1. Grading tests which were performed at the time of the contract on material sampled from various gravel bars, stockpiles, test pits, stabilization trenches, etc., showed quite a range of passing #200, 1% - 7%, with an average of about 3%. Water flowed through this in-place filter material rather slowly and had a tendency to puddle, which might be an indication of non-uniformity in the grading. Laboratory permeability tests on the four samples of the old filter material gave permeability values of 0.1 to 3.0 feet per day. At times of high flow (rainy season, etc.) materials

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with this permeability cannot carry the water to the perforated metal pipe fast enough for the underdrain to function properly. The district also obtained a sample of this old filter material and their grading test showed 7% passing the #200 sieve.

Effectiveness of Underdrains After Rehabilitation

The grading specifications for the new filter material which was placed under Contract No. 58-1TC12 are as follows:

Sieve Size	% Passing
1"	100
3/4"	90 - 100
3/8"	20 - 55
No. 4	0 - 15
No. 8	0 - 5
No. 200	0 - 2

The gradings of several samples obtained from trenches and trucks showed that the material met these specifications. The grading of one sample obtained from the trench is shown on Chart No. 2 and permeability tests indicate values of 200 - 300 feet per day. With the perforated metal pipe exposed to this material at 25 foot intervals, any water entering the underdrains should be carried to the pipe.

Conditions Encountered During Rehabilitation

The perforated metal pipe in the underdrains was in good condition with no signs of corrosion or plugging of the holes where the pipe was installed as planned. There was a small amount of silt collecting near the outlets of the underdrains, probably indicating some washing of the filter material during periods of large flows of water. There appeared to be no evidence of migration of the original ground into the filter material. The efficiency of the underdrains was impaired at numerous locations due to poor construction practices, See Table No. 1.

This list shows the conditions at locations where the pipe was uncovered. The pipe was uncovered at 25 ft. intervals and it is a matter of speculation as to the condition of the underdrains in the areas between the inspection points. At locations where the clay seal was on or around the perforated metal pipe, all the clay was removed, and the trench was backfilled with new filter material.

It was also noted that seepage from underground springs is showing on six cut faces, on the right at the following locations: "D" 208+80, "D" 222+00, "D" 239+00, "D" 365+50, "E" 381+00 and "E" 383+00. See Photos Nos. 13 and 14. Pumping has been observed in these areas during the past few years and no underdrains had been installed in these areas.

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Structural Section

During the rehabilitation and installation of the underdrains measurements of the structural section were made at numerous locations, see Table No. 2. The condition of the plant mix surfacing and cement treated base was noted. Samples of the subbase, select material and basement soil were taken and delivered to the headquarters laboratory for "R" value determinations.

The specifications called for 3 inches of plant mixed surfacing over 6 inches of Class "A" cement treated base over a pervious subbase of 9 inches to 15 inches. From the measurements of the structural section it is obvious that the as-built section deviates considerably from the design section. The cement treated base varied in thickness and was somewhat broken where failure areas were excavated. In several locations water was flowing between the PMS and the CTB, and occasionally water was found in the bottom 1" to 2" of the PMS. The cracked and soft areas of the CTB appeared to be quite pervious, see Photos Nos. 15, 16, 5, 17, 18, 19 and 20. Some of the large voids in the CTB maintained a small stream of water for a short period of time after cutting, and remained wet until sealed in preparation for paving. Some cobbles up to 2 feet in diameter were found in the pervious subbase. It is possible that the thin portions of the CTB were the result of the road mixer riding over these rocks.

Conclusions

1. The clay seal in the underdrains prevented the water in the cut sections and the pervious subbase from entering the underdrains.

2. The cross drains, as constructed with a clay seal, were of little or no value. Any water flowing through the pervious subbase could not percolate through the clay seal but flowed into the structural section in the fill areas.

3. The in-place filter material contained too much material passing the No. 200 sieve. When compacted, it has a low permeability and during periods of high flow water could not percolate through it fast enough to maintain a relatively dry roadbed.

4. Poor construction practices resulted, in numerous instances, in underdrains that could not function properly.

5. In several locations flowing springs were found on cut faces and evidently considerable water flows through the pervious subbase and through the pavement at some point downgrade.

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Recommendations

On future projects a clay seal should not be used over the underdrains and under a paved shoulder or an all paved section. There might be cases where a clay seal was desirable if the area was not to be covered with base or pavement.

Further studies and observations should be made in order to improve the specifications for filter material. The Materials and Research Department will continue studies on the specifications. In the meantime the special provisions should specify slightly less fines than the present standard specifications permit and should contain some provision regarding the durability of the filter material.

On individual projects, ample funds should be provided to construct underdrains. In addition to the underdrains shown on the plans, they should be installed at other locations where conditions develop during construction that indicate subsurface water that can be handled by underdrains. There is probably a tendency to install drains that are not deep enough and precautions should be taken to guard against this tendency.

Revised specifications will be prepared in the near future that will cover grading and durability requirements for filter material.

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TABLE NO. 1

Deficiencies Noted While Rehabilitating Underdrains

Station	Deficiency
"D" 218± to 219+60	Approx. 160' of PMP not placed
"D" 269+30 to 269+40	Approx. 10' of PMP missing. Trench filled with clay to top of underdrain. See Photo No. 7.
"D" 269+50 to 271+28	Clay seal around top of pipe. Effective depth of underdrain about 1 ft. (Thickness of filter material)
"D" 280+00 to 280+30	Perforations on side of pipe. Clay seal around pipe. See Photo No. 8.
"D" 280+90 to 281±	Approx. 10' of PMP missing.
"D" 304+65	Approx. 6' of PMP flattened. See Photo No. 9.
"D" 331+20 to 332+40	Clay seal around top portion of PMP. Effective depth of underdrain is about 1-1/2 ft.
"D" 333+10	No band coupling. PMP's separated 2" to 3". Clay in PMP from earth seal.
"E" 409+70	Ditto. See Photo No. 10.
"D" 352+71*	Approx. 10' of PMP missing. Underdrain full of clay.
"E" 396 to 398+25	Clay seal around top of PMP. Effective depth of underdrain is about 1 ft. See Photo No. 11.
"D" 353+00	Approx. 2 sq. ft. area of PMP cut with torch & rusted.
"E" 410+05	Crushed PMP with clay seal around pipe. See Photo No. 12.
"E" 409+07 to 412+00	Clay around top of PMP. Effective depth of underdrain is 1-1/2 ft.

*Found and corrected in September, 1955.

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TABLE NO. 2

Measurements of Structural Section
All measurements in Feet

Station	P.M.S.	C.T.B.	Subbase	Remarks
		Rehabilitated Longitudinal Underdrains		
D 261+00	0.20	0.40	1.4	Very wet 1' above clay seal.
D 262+15	0.20	0.50	1.5	Free water above clay seal.
D 263+00	0.23	0.50	1.6	Subbase very wet.
D 267+30	0.21	0.54	1.25	Clay around pipe.
D 269+50	0.25	0.50	1.00	Clay on pipe. All of subbase is saturated.
D 270+50	0.27	0.58	1.15	Free water above clay seal.
D 279+50	0.25	0.50	1.50	Free water below clay seal.
D 280+50	0.25	0.50	1.33	Free water above clay seal.
D 290+00	0.23	0.40	1.58	Subbase is damp to wet.
D 304+65	0.25	0.42	1.17	Subbase is wet to saturated throughout.
D 332+00	0.21	0.43	1.21	Clay on the pipe.
D 333+50	0.25	0.50	1.17	Subbase is saturated.
		Rehabilitated Longitudinal Underdrain Sta. "D" 344+50 to 347+80		
344+75	0.25	0.50	1.00	Subbase is saturated.
345+00	0.23	0.54	1.25	
345+25	0.42	0.42	1.17	
345+50	0.29	0.46	1.25	
345+75	0.25	0.50	0.83	
346+00	0.27	0.42	1.17	See Photo No. 4.
346+25	0.26	0.50	0.58	
346+50	0.21	0.52	0.50	
346+75	0.23	0.58	0.58	
347+00	0.23	0.50	0.75	
347+25	0.25	0.58	0.92	
347+50	0.22	0.58	0.58	
347+70	0.19	0.62	0.42	
		Rehabilitated Longitudinal Underdrain Sta. "D" 362+00 to 364+25		
362+00	0.25	0.54	1.25	
362+25	0.27	0.52	1.33	
362+50	0.25	0.58	1.42	
362+75	0.21	0.67	1.17	
363+00	0.23	0.50	1.25	
363+25	0.25	0.50	1.08	
363+50	0.29	0.54	1.17	
363+75	0.23	0.62	1.00	
364+00	0.25	0.52	0.83	
364+25	0.25	0.56	1.17	24' of pipe is missing.

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TABLE NO. 2 (Cont.)

Station	P.M.S.	C.T.B.	Subbase	Remarks
	Rehabilitated Longitudinal Underdrain Sta. "E" 373+16 to 374+25			
373+50	0.21	0.29	0.75	
373+75	0.18	0.58	0.67	
374+00	0.23	0.50	0.58	Subbase is quite clayey. See Photo No. 21.
374+25	0.27	0.54	0.58	P.M.P. not to end of underdrain.
	Rehabilitated Longitudinal Underdrain Sta. "E" 375+27 to 377+57			
375+30	0.29	0.46	0.58	
375+50	0.25	0.67	0.25	
375+75	0.29	0.54	0.50	
376+00	0.29	0.50	0.67	See Photo No. 22.
376+25	0.29	0.50	1.17	
376+50	0.21	0.48	1.17	
376+75	0.19	0.54	1.17	Layers of clay in subbase.
377+00	0.19	0.58	1.17	
377+25	0.17	0.58	1.25	
377+50	0.21	0.50	1.00	
	Rehabilitated Longitudinal Underdrain Sta. "E" 394+30 to 398+50			
394+50	0.25	0.29	0.83	
394+75	0.25	0.50	1.08	
395+00	0.21	0.50	1.17	
395+25	0.23	0.46	1.25	
395+50	0.37	0.42	1.17	
395+75	0.35	0.50	1.17	
396+00	0.29	0.58	1.08	Clay on P.M.P.
396+25	0.27	0.58	1.08	Free water on top of clay seal.
396+50	0.33	0.50	1.00	
396+75	0.21	0.58	1.33	
397+00	0.27	0.46	1.50	
397+25	0.21	0.50	1.25	Water on top of clay seal. See Photo No. 11.
397+50	0.17	0.54	1.17	
397+75	0.19	0.58	1.08	
398+00	0.19	0.50	1.00	See Photo No. 23.
398+25	0.23	0.50	0.92	
398+50	0.25	0.54	1.08	

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TABLE NO. 2 (Cont.)

Station	P.M.S.	C.T.B.	Subbase	Remarks
		Rehabilitated Longitudinal Underdrain Sta. "E" 409+07 to 412+00		
409+10	0.35	0.17	1.00	Clay on P.M.P.
409+25	0.37	0.39	0.75	" " "
409+50	0.29	0.37	0.50	" " "
409+70	0.27	0.39	0.67	" " "
410+00	0.25	0.42	0.92	" " "
410+05	0.25	0.42	0.58	" " "
410+30	0.23	0.50	0.50	" " "
410+50	0.21	0.50	0.67	" " "
410+75	0.20	0.50	0.50	
411+00	0.21	0.48	0.42	
411+25	0.25	0.56	0.58	Clay on P.M.P.
411+50	0.25	0.50	0.58	" " "
411+75	0.19	0.75	0.50	" " "
		New Underdrain on ℄ Sta. "D" 344+00 to 347+25		
344+00	0.25	0.50	0.67	Free water in subbase.
344+10	0.25	0.50	0.67	" " " "
344+20	0.29	0.50	0.79	" " " "
344+30	0.29	0.42	0.83	" " " "
344+40	0.29	0.46	0.83	" " " "
344+50	0.25	0.42	0.92	" " " "
344+60	0.29	0.46	0.83	" " " "
344+70	0.25	0.50	0.83	" " " "
344+80	0.29	0.42	0.87	" " " "
344+90	0.25	0.50	0.83	" " " "
345+00	0.25	0.50	0.83	" " " "
345+10	0.25	0.46	0.87	
345+20	0.29	0.37	0.83	Subbase is saturated
345+30	0.25	0.54	0.71	" " "
345+40	0.29	0.46	0.71	" " "
345+50	0.27	0.42	0.75	" " "
345+60	0.27	0.46	0.65	" " "
345+70	0.29	0.50	0.79	" " "
345+80	0.29	0.44	0.77	" " "
345+90	0.29	0.54	0.58	" " "
346+00	0.27	0.50	0.73	" " "
346+10	0.25	0.42	0.83	" " "
346+20	0.29	0.50	0.71	" " "
346+30	0.29	0.50	0.71	" " "
346+40	0.35	0.50	0.65	" " "
346+50	0.29	0.50	0.62	" " "
346+60	0.37	0.46	0.58	" " "
346+70	0.35	0.58	0.39	" " "
346+80	0.29	0.50	0.54	" " "
346+90	0.29	0.54	0.58	" " wet.
347+00	0.27	0.46	0.69	" " "
347+15	0.29	0.58	0.62	" " "
347+25	0.25	0.50	0.58	

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TABLE NO. 2 (Cont.)

Station	P.M.S.	C.T.B.	Subbase	Remarks
		New Underdrain on Ḃ Sta. "D" 367+00 to 369+00		
367+70	0.33	0.50	0.67	Subbase is saturated.
367+80	0.35	0.42	0.73	" " "
367+90	0.33	0.50	0.67	" " "
368+00	0.29	0.42	0.79	" " "
368+10	0.31	0.37	0.73	Free water in subbase.
368+20	0.31	0.54	0.57	" " " "
368+30	0.31	0.42	0.69	" " " "
368+40	0.27	0.46	0.77	" " " "
368+50	0.27	0.42	0.81	" " " "
368+60	0.25	0.50	0.75	Subbase is wet.
368+70	0.25	0.50	0.75	" " "
368+80	0.25	0.50	0.75	" " "
368+90	0.25	0.54	0.71	" " "
369+00	0.25	0.50	0.75	" " "
		New Underdrain on Ḃ Sta. "D" 369+73 to 370+75		
369+75	0.33	0.42	0.75	Subbase is damp to wet.
370+00	0.29	0.46	0.75	See Photo No. 17 and 18.
370+25	0.23	0.50	0.52	
370+50	0.25	0.42	0.75	
370+75	0.27	0.50	0.65	
		New Underdrain on Ḃ Sta. "E" 394+50 to 398+00		
394+50	0.31	0.42	0.83	Free water throughout structural section.
394+75	0.31	0.37	1.40	Ditto.
395+00	0.25	0.42	1.50	Ditto.
395+25	0.33	0.42	1.25	Ditto.
395+50	0.29	0.50	1.29	Ditto.
395+75	0.31	0.42	1.26	Ditto.
396+00	0.25	0.46	1.29	Ditto.
396+25	0.29	0.42	1.29	Saturated structural section.
396+50	0.25	0.50	1.33	Ditto.
396+75	0.25	0.46	1.37	Ditto.
397+00	0.23	0.46	1.48	Ditto.
397+25	0.29	0.33	1.47	Ditto.
397+50	0.29	0.42	1.29	Ditto.
397+75	0.25	0.50	0.93	Ditto.
398+00	0.29	0.42	1.04	Ditto.

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TABLE NO. 2 (Cont.)

Station	P.M.S.	C.T.B.	Subbase	Remarks
		New Underdrain on Ł Sta. "D" 332+00 to 337+00		
332+50	0.29	0.42	1.12	Water between CTB & PMS.
332+75	0.31	0.44	1.25	" " " " "
333+00	0.33	0.42	1.17	" " " " "
333+25	0.29	0.46	1.25	" " " " "
333+50	0.35	0.52	1.13	CTB is pervious.
333+75	0.35	0.48	1.09	" " "
334+00	0.33	0.42	0.83	CTB is soft and wet.
334+25	0.31	0.44	0.75	" " " " "
334+50	0.25	0.42	0.50	" " " " "
334+75	0.25	0.42	0.50	Subbase is saturated.
335+00	0.35	0.33	0.49	" " "
335+25	0.35	0.42	0.56	" " "
335+50	0.29	0.46	0.67	" " "
335+75	0.29	0.37	0.67	Water between CTB & PMS.
336+00	0.33	0.37	0.80	" " " " "
336+25	0.37	0.37	0.68	Subbase is wet.
336+50	0.33	0.42	0.67	" " "
336+75	0.35	0.44	0.71	" " "
337+00	0.25	0.46	0.71	" " "
		New Underdrain on Ł Sta. "E" 379+75 to 382+00		
379+75	0.31	0.44	1.17	Pervious CTB, Saturated subbase.
380+00	0.25	0.50	1.53	Ditto.
380+25	0.29	0.33	1.46	Ditto.
380+50	0.25	0.46	1.21	Ditto.
380+75	0.25	0.50	1.33	Ditto.
381+00	0.27	0.48	1.25	Pervious CTB. Water under PMS. See Photo No. 15, 19, & 20.
381+25	0.33	0.37	1.30	Pervious CTB. Water under PMS.
381+50	0.27	0.50	1.48	Ditto. See Photo No. 16.
381+75	0.25	0.42	1.58	Pervious CTB. Water under PMS.
382+00	0.31	0.44	1.42	Ditto.

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TABLE NO. 2 (Cont.)

Station	P.M.S.	C.T.B.	Subbase	Remarks
		New Underdrain Left of Ł Sta. "E" 394+50 to 398+00		
394+50	0.25	0.58	1.17	Subbase is saturated; CTB
394+75	0.31	0.45	1.24	wet and soft. Water between
395+00	0.29	0.50	1.29	CTB and PMS.
395+25	0.25	0.37	1.55	Ditto.
395+50	0.27	0.48	1.33	Ditto.
395+75	0.33	0.42	1.33	Ditto.
396+00	0.29	0.46	1.33	Ditto.
396+25	0.25	0.50	1.25	Ditto.
396+50	0.25	0.58	1.17	Ditto.
396+75	0.33	0.50	1.17	Ditto.
397+00	0.46	0.37	1.17	Free water in subbase.
397+25	0.35	0.50	1.23	" " " "
397+50	0.33	0.50	1.34	" " " "
397+75	0.21	0.54	1.33	" " " "
398+00	0.21	0.54	1.17	" " " "
		Rehabilitation at Sta. "D" 288+90 to 289+25		
288+90	0.17	0.37	1.29	Subbase is saturated above clay seal.
288+95	0.15	0.42	1.26	Ditto.
289+00	0.17	0.50	1.33	Ditto.
289+05	0.15	0.37	1.56	Ditto.
289+10	0.17	0.42	1.41	Ditto.
289+15	0.21	0.50	1.37	Ditto.
		New Underdrain Left of Sta. "E" 379+40 to 381+00		
379+50	0.29	0.42	1.37	Subbase & CTB is saturated.
379+75	0.31	0.44	1.33	" " " " "
380+00	0.33	0.46	1.29	" " " " "
380+25	0.25	0.42	1.33	" " " " "
380+50	0.29	0.42	1.29	" " " " "
380+75	0.21	0.37	1.42	" " " " "
381+00	0.21	0.46	1.33	
		New Underdrain Left of Sta. "D" 332+46 to 335+50		
332+50	0.25	0.42	1.33	Subbase & CTB is wet & soft.
332+75	0.21	0.46	1.16	" " " " " " "
330+00	0.23	0.33	1.19	" " " " " " "
333+25	0.21	0.42	0.95	
333+50	0.21	0.35	1.02	Subbase is wet.
333+75	0.23	0.33	0.94	Water in CTB.
334+00	0.21	0.37	1.00	" " "
334+25	0.21	0.29	1.25	" " "
334+50	0.25	0.29	1.04	Subbase is wet.
334+75	0.23	0.29	0.98	" " "
335+00	0.21	0.33	1.13	" " "
335+25	0.21	0.42	0.97	" " " (free water)
335+50	0.25	0.37	0.88	" " " (" ")

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TABLE NO. 2 (Cont.)

Station	P.M.S.	C.T.B.	Subbase	Remarks
New Crossdrain at Sta. "D" 344+25				
℄	0.21	0.58	0.79	Free water in subbase.
2' Lt.	0.17	0.58	1.08	" " " "
5' Lt.	0.21	0.37	1.09	" " " "
7' Lt.	0.21	0.33	1.04	" " " "
10' Lt.	0.21	0.33	0.71	" " " "
New Crossdrain at Sta. "D" 332+46				
℄	0.33	0.42	1.08	CTB not uniform.
8' Lt.	0.29	0.46	1.08	" " "
14' Lt.	0.27	0.42	1.10	" " "
Rehabilitated Crossdrain at Sta. "D" 335+25				
℄	0.27	0.35	1.37	
14' Rt.	0.25	0.29	1.46	
Rehabilitated Crossdrain at Sta. "D" 335+75				
℄	0.27	0.42	0.62	
14' Rt.	0.27	0.35	0.92	
New Crossdrain at Sta. "E" 370+75				
14' Lt.	0.25	0.46	0.58	CTB is fairly uniform.
20' Lt.	0.25	0.46	0.54	
26' Lt.	0.25	0.42	0.62	
New Crossdrain at Sta. "E" 379+75				
℄	0.23	0.44	1.62	CTB is fairly uniform.
9' Lt.	0.23	0.39	1.62	
16' Lt.	0.23	0.44	1.50	
23' Lt.	0.27	0.39	1.67	
26' Lt.	0.25	0.35	1.67	
New Crossdrain at Sta. "E" 394+50				
℄	0.25	0.50	1.00	CTB is nonuniform, fairly soft.
9' Lt.	0.23	0.52	1.02	
16' Lt.	0.21	0.54	1.08	
Rehabilitated Underdrain, Right of Sta. "E" 419+25				
419+25	0.23	0.42	1.35	CTB is fairly uniform, moderately hard.
419+50	0.23	0.42	1.33	
419+75	0.21	0.42	1.35	

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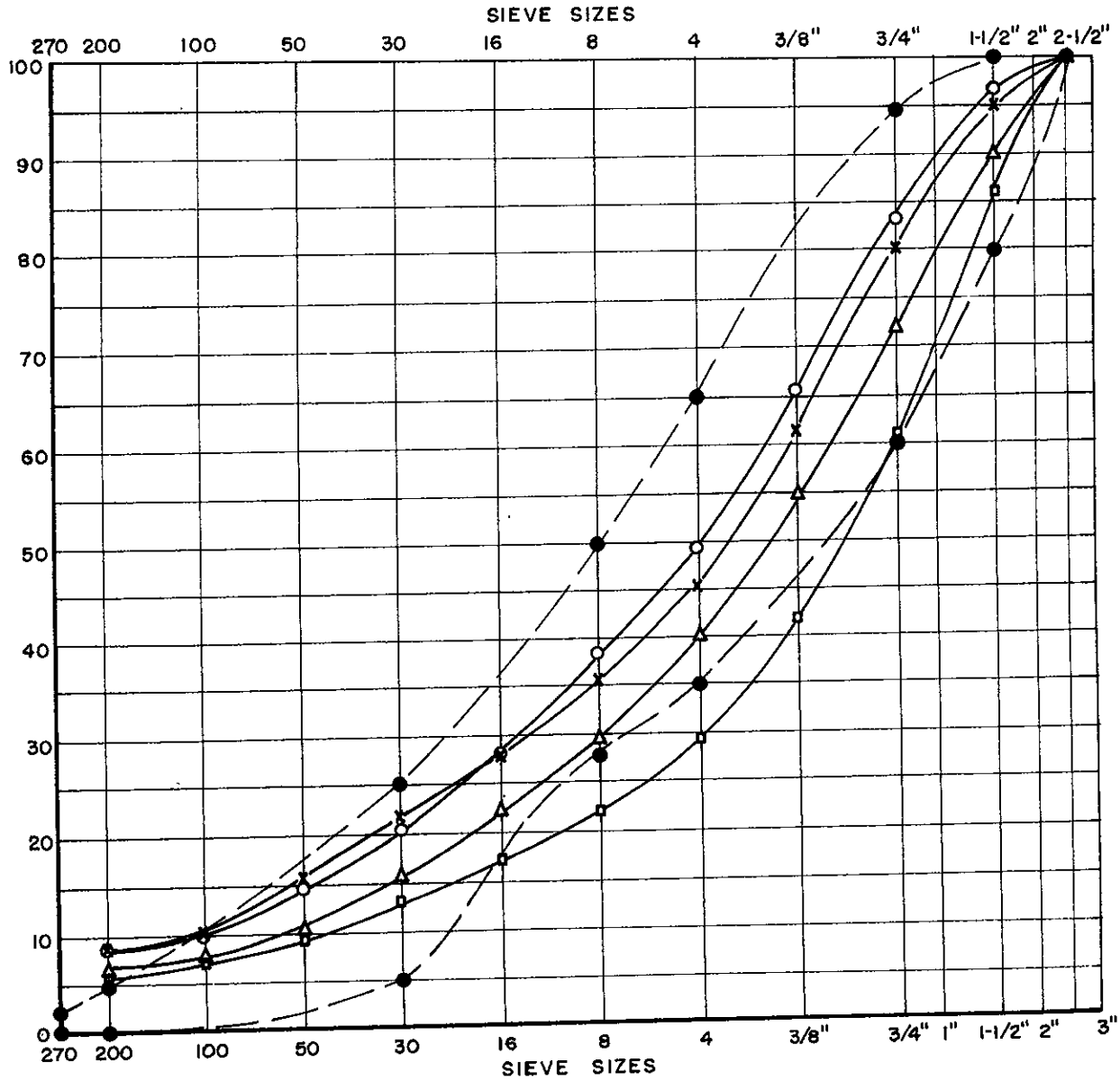
I-Men-I-D,E
Ridgewood Summit
GRADING OF FILTER MATERIAL
Contract No 53-ITC12



△ - Test No. 57-1612
□ - Test No. 57-1613
○ - Test No. 57-1580
× - Test No. 57-1640
—●—●— Spec. Limits

Chart I.

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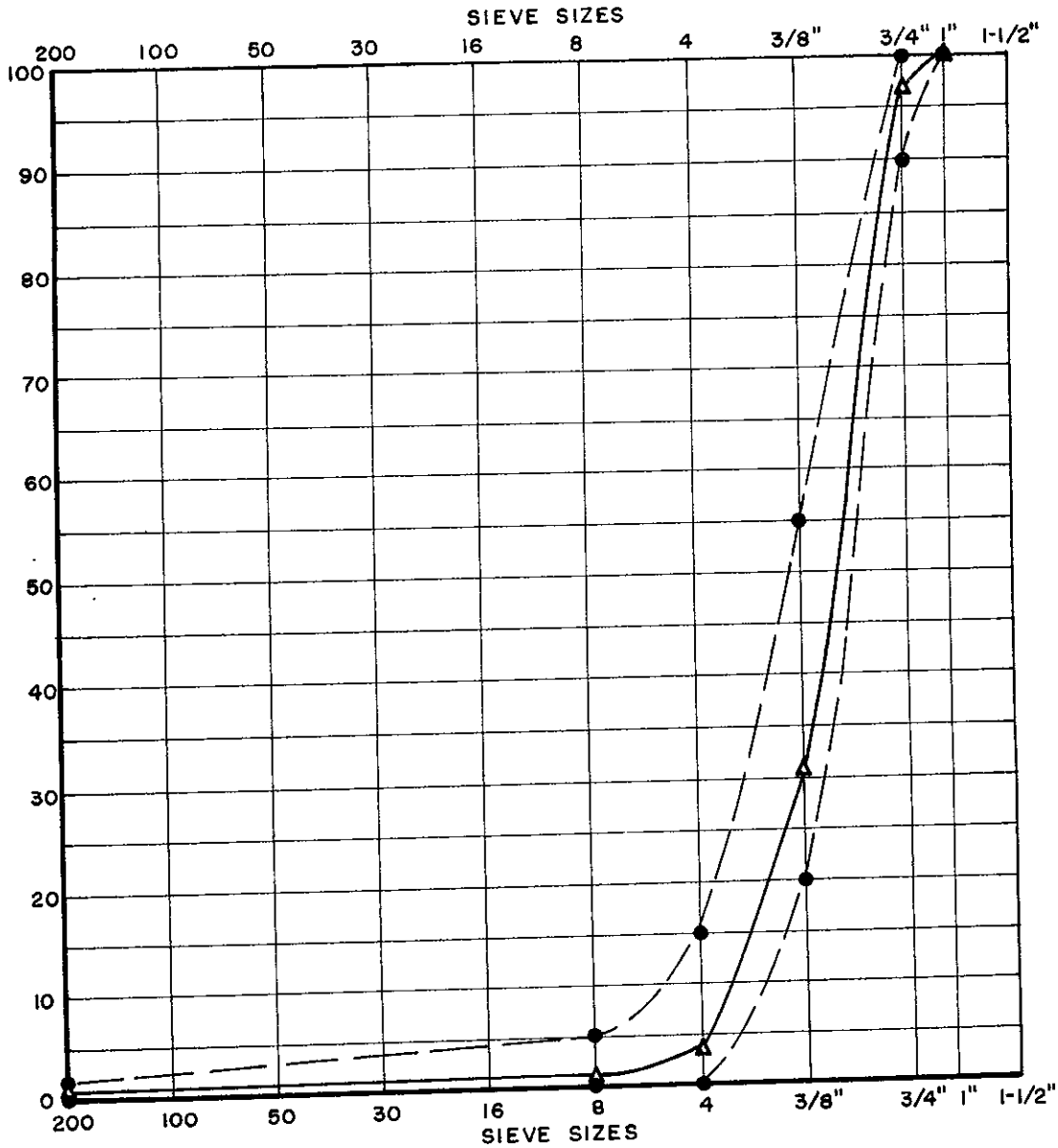
I-Men-I-D,E
Ridgewood Summit
GRADING OF FILTER MATERIAL
Contract No 58-ITC12



Δ - Test No. 57-1579

—●—●— Spec. Limits

Chart 2.

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Photo No. 1 7-10-57
Sta. "D" 332+00. Note impervious clay below pervious subbase. Cut on right, fill on left.

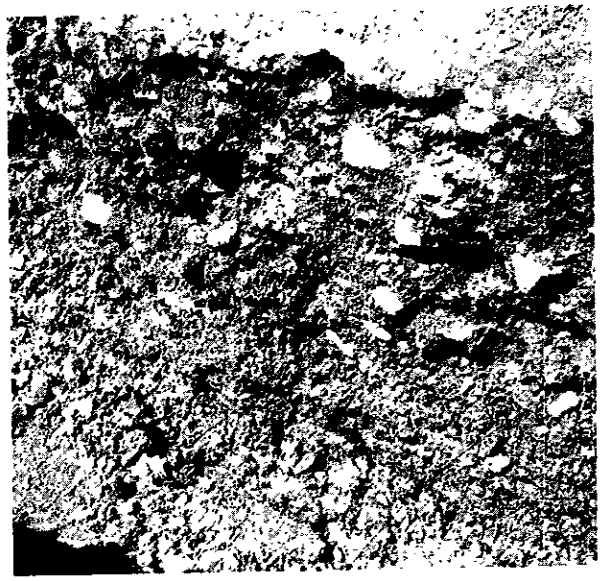

Photo No. 2 7-11-57
Sta. "D" 333+40. Water flowing from pervious subbase.

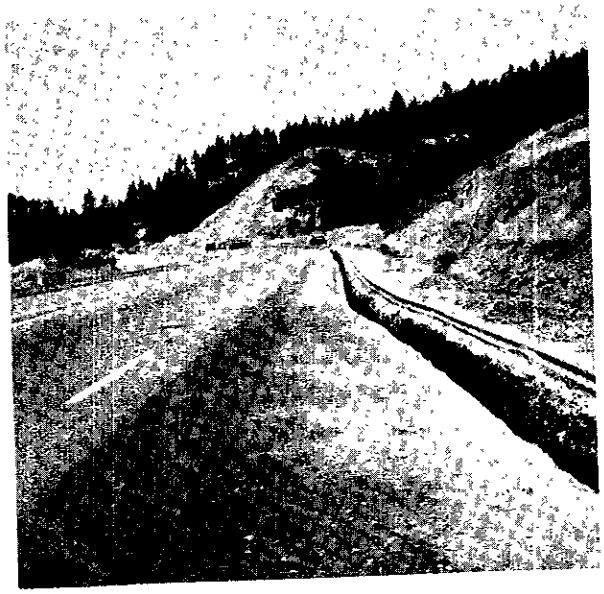

Photo No. 3 7-15-57
Sta. "D" 345+50 to 347+50. Underdrain in outer wheel track of outer northbound lane.

Photo No. 4 7-15-57
Sta. "D" 345+90. Note water flowing from pervious subbase and CTB.

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Photo No. 5 8-1-57
Sta. 347+50. Water between PMS and CTB. Considerable water in the CTB and below it.

Photo No. 6 7-25-57
Sta. "D" 345+70. Note earth seal and structural section thickness of 1'-6".

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Photo No. 7 7-8-57
Sta. "D" 269+30

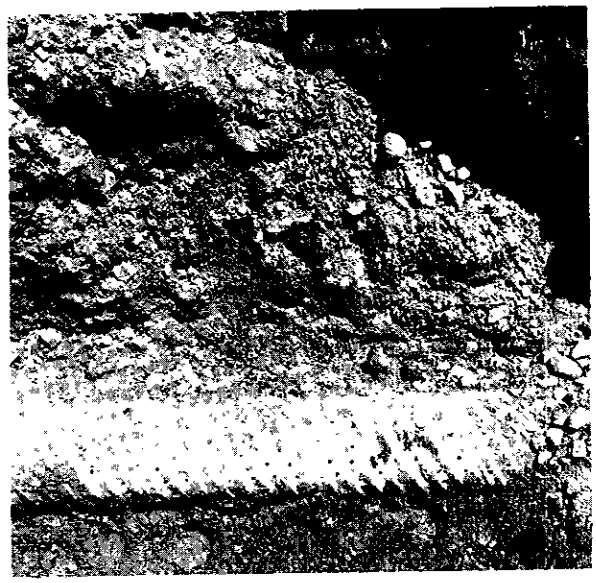

Photo No. 8 7-9-57
Sta. "D" 280+00 to 280+30

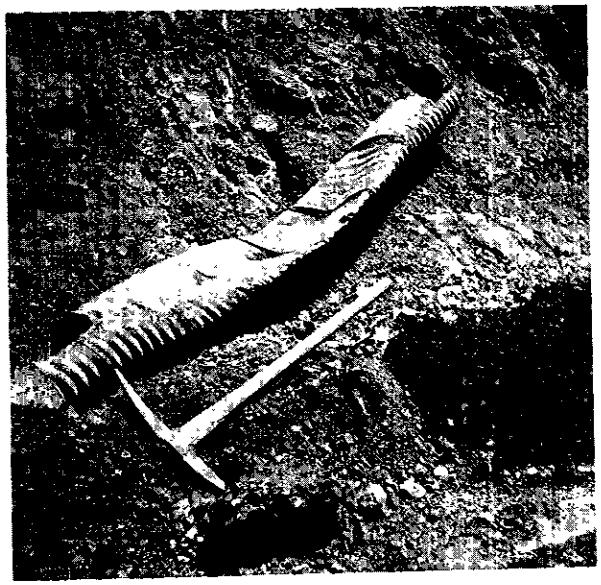

Photo No. 9 7-10-57
Sta. "D" 304+65

Photo No. 10 7-24-57
Sta. "E" 409+70

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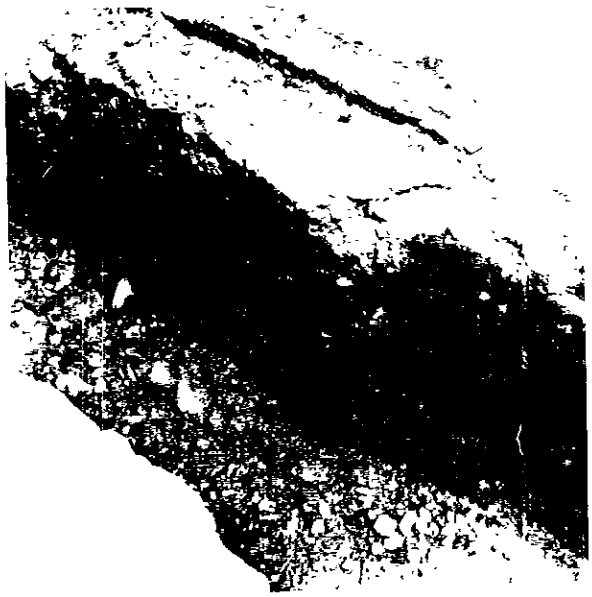

Photo No. 11 7-23-57
Sta. "E" 397+25. Note free water flowing over earth seal.

Photo No. 12 7-24-57
Sta. "E" 410+05. Crushed P.M.P. with clay in and around pipe. Note relatively thin structural section.

Photo No. 13 8-1-57
Right of Sta. "E" 383±. Spring area no under-drains installed on Contract 53-1TC12-F.

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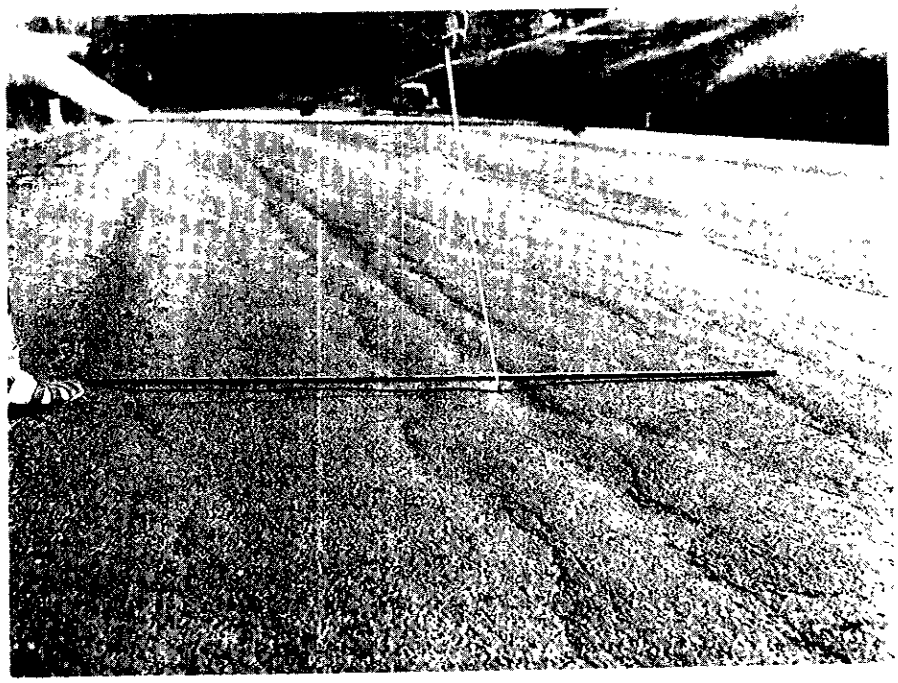

8-1-57

Photo No. 14
Sta. "E" 383±. Depressed outer wheel track, southbound lanes.

8-1-57

Photo No. 15.
Right side of new trench. Sta. "E" 381+00.

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Photo No. 16 8-1-57
Water cavity on right side of E. Sta. "E" 381+50.

Photo No. 17 7-28-57
Left side of new underdrain. Sta. "E" 369+73 to "E" 370+15. Note free water between PMS and CTB. The CTB is soft and wet.

Photo No. 18 7-29-57
Sta. "E" 370+00. Water between PMS and CTB. The CTB is soft and wet.

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Photo No. 19 7-31-57
Approx. Sta. "E" 381. Pervious CTB, large voids.

Photo No. 20 7-21-57
Approx. Sta. "E" 381. Pervious CTB, large voids.

Photo No. 21 7-23-57
Sta. "E" 374+00. Structural Section 1'-6" thick. Rule sitting on top of earth seal. Note moisture above earth seal.

Photo No. 22 7-23-57
Sta. "E" 376+10. Note the structural section. Note the moisture in the pervious subbase.

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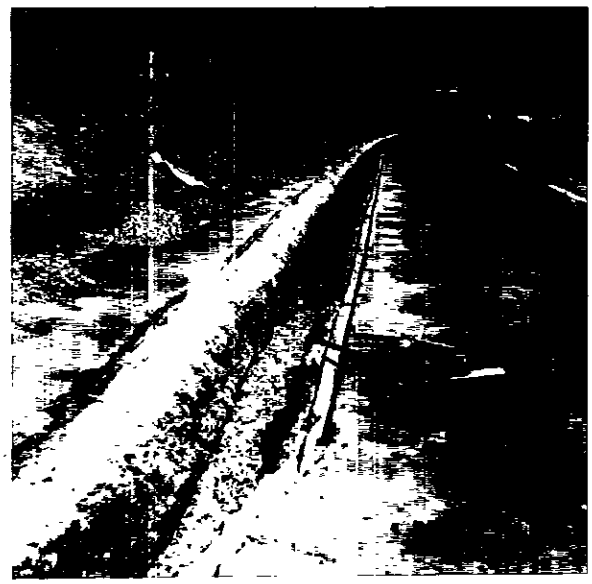

Photo No. 23 7-23-57
Looking back from Sta. "E" 398
Water flowing from pervious subbase
into open trench.

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