EXPERIMENTAL USE OF HOT RECYCLED ASPHALT PAVEMENT IN VERMONT

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AGENCY OF TRANSPORTATION
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16. Abstract An 11.7 mile portion of Vermont Rte 15 in Essex-Jericho-Underhill was paved with a leveling and surface course of recycled bituminous concrete pavement. Nearly 18,000 tons of the mix containing up to 35 percent reclaimed pavement material, was produced in a standard batch plant using the heat transfer method. Modifications to the plant were limited to a flowboy-elevator feed system which was wired into the plant's automated scales and controls. The use of the reclaimed bituminous concrete pavement did not significantly reduce the production capability of the 6 ton batch plant or cause problems in producing specification material.

Since the recovered penetration values of the reclaimed pavement were in the range of 55 to 65, no rejuvenating agent or softer grade of asphalt was specified for the recycled mix.

No visual difference could be noted between the recycled mix and the standard mix placed on the control sections. However, the recycled mix was less susceptible to shoving under initial compaction and was more difficult to work by hand due to its' increased stiffness as further evidenced by stability and flow values obtained in daily lab tests.

Savings in natural resources obtained with the use of the recycled mix included 4796 tons of new aggregate and 330 tons of asphalt cement.

Savings in energy totaled 86,370 BTU/ton of 30% recycled mix and 112,590 BTU/ton of 35% recycled mix with energy savings for the project totaling 1,536,483,610 BTU. Although no reduction in price was negotiated, it is assumed that cost savings will be attained on future projects where recycled mix is utilized.

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INTRODUCTION

Spiraling highway construction and energy costs, scarcity of suitable aggregate and asphalt supplies, and a leveling off of gas tax revenues, have forced Highway Agencies to seek alternate methods or materials for the construction and maintenance of highway systems. The reuse of existing deteriorated bituminous pavements as a portion of new bituminous concrete mixes, a process commonly called recycling, is a construction method which offers potential cost savings through the conservation of aggregate and asphalt plus reduced use of energy.

The widespread promotion of recycling began in June, 1976 with the initiation of Demonstration Project No. 39, Recycling Asphalt Pavements. Since that time, the Demonstration Project has provided partial funding for the construction and evaluation of approximately 70 installations involving hot, cold, and surface recycling. Over the past 6 years, in excess of 15 million tons of asphalt paving materials have been recycled. In most cases, the recycled mixes have performed satisfactorily and in some instances are even out performing mixes produced with virgin materials.

The first use of hot recycling in Vermont occurred in June 1981 when the contractor awarded an 11.8 mile paving project requested permission to use pavement material being removed from a nearby construction project. Since an earlier Materials & Research Division study had concluded that the material could be recycled with satisfactory results, permission was granted to produce recycled mix providing all specifications in the contract were complied with.

This report covers the construction phase of Vermont's first hot recycle project carried out under Demonstration Project No. 39, Recycling Asphalt Pavements.

PROJECT DESCRIPTION AND ROADWAY CONDITION

The recycled bituminous concrete pavement was placed on two sections of Vermont Rte. 15 totaling 11.79 miles. The westerly section began in the Town of Essex, at the Essex Junction east village limits and extended northeasterly 1.27 miles to the intersection with Town Highway 702. The easterly section also began in the Town of Essex, 600 feet east of the Sand Hill Road intersection, and extended northeasterly through the Town of Jericho into the Town of Underhill, a distance of 10.52 miles, ending at the Town Highway No. 9 intersection. The project area is located in Chittenden County in northwestern Vermont, adjacent to Lake Champlain.

Climatological data for the project area discloses an average freezing index of 1186, an average of 74 freeze-thaw cycles and 73 inches of snowfall. Frost penetration within the roadway cross section could be expected to reach a depth of 60 inches.

Construction and maintenance records do not date back to the time of initial construction of Rte. 15 in the areas in question. The records do indicate the sub-base consisted of gravel ranging from 6 to 18 inches in depth. The roadway was first treated with a bituminous surface in a series of projects between 1933 and 1939. Additional courses included an average of 5 blade mixes between 1951 and 1963, one bituminous seal coat in the early 60's and approximately 1 inch of plant mix placed in 1 course in the mid 60's or as a 3/8 inch course placed in the mid 60's and again in the early 70's. Due to the number and variety of treatments, no attempt was made to sample and test the materials for their remaining physical properties.

The condition of the riding surface was fairly consistent over the length of the project with the exception of a few localized areas which were severely cracked and rutted. The latter failures all appeared to be base related. The roadway had been given a Pavement Serviceability Rating of 2.3 out of a possible maximum value of 5.0. Sufficiency ratings for structural condition including pavement condition, ranged from 19 to 29 out of a possible 50 points while the overall rating adjusted for traffic ranged from 23 to 60 out of a maximum of 100.

Detailed pavement condition surveys were made at 10 locations on the project. The results of the surveys revealed an average of 396 lineal feet of cracks per 100 lineal feet of 24.3 foot roadway. Longitudinal cracks made up 88 percent of the total, followed by 6 percent miscellaneous cracks and 6 percent transverse. In most cases, the longitudinal cracking patterns consisted of a series of short parallel cracks covering up to 3 feet in width. They did not occur with any greater frequency in the wheel paths than at other locations.

The cracks ranged from 1/8 inch to 1 1/2 inch in width with an average width of 1/4 inch. It should be noted that all crack width measurements were recorded in June during periods of relatively high ambient temperatures, therefore, such widths would increase significantly during colder weather. There were very few signs of surface raveling on the project.

Figure 2 Condition Of Old Pavement Surface On Test Section No. 4

Wheel path rutting on the westbound lane averaged 1/2 inch in the outside wheel path and 1/4 inch in the wheel path adjacent to the centerline. Values on the eastbound lane were similar with a 7/16 inch average on the outside and 1/4 inch on the inside. The maximum rutting noted within the test sections was 1 13/16 inches.

Average daily traffic volume on the project varied with the proximity to the greater Burlington urban area. The volume in the Essex area averaged 9213 vehicles while volumes west of Jericho averaged 6032. The area between Jericho and Underhill totaled 4466 with 2274 recorded northeast of Underhill. Truck traffic was estimated at 6 percent on all areas.

CONTRACT DESCRIPTION

The construction contract, Essex-Jericho-Underhill FR 030-1(11), was awarded on the 28th of May, 1981 to Pike Industries, Inc. of Tilton, New Hampshire with a completion date requirement of August 14, 1981. The treatment specified for the pavement rehabilitation project included a tack coat of emulsified asphalt, placement of a nominal 1/2 inch leveling course and a 1 1/2 inch surface course of Type III bituminous concrete mix. The design quantity for the project was estimated at 19,050 tons of mix.

On June 16, 1981, the contractor requested permission to produce recycled bituminous concrete mix for the project. The request came about as the result of their acquisition of approximately 11,000 tons of reclaimed pavement from a nearby Interstate 89 paving project (Bolton-Richmond IR 89-2(1)). The pavement material being removed had been examined extensively by the Materials & Research Division the previous year with the conclusion that it could be recycled with satisfactory results. Based upon that information, permission was granted to produce recycled mix and place it as both leveling and surface courses.

ANALYSIS OF RECLAIMED PAVEMENT

The pavement millings became available for the Rte. 15 project as a result of numerous pavement surface failures which occurred on a 7.6 mile section of Interstate 89 paved in 1975. The major cause of the premature pavement failure related to the use of a strain relieving interlayer (SRI) of shredded rubber and fine aggregate in an emulsion slurry which had been placed on the old pavement surface in an attempt to reduce reflective cracking. The actual failure mechanism involved the SRI's tendency to act as a flexible interlayer and as a possible moisture barrier causing surface moisture to be retained in the overlay. This in turn resulted in stripping of the asphalt from the coarse aggregate under traffic.

A 1979 - 1980 investigation of the 1975 overlay material included its acceptability for cold recycling, the need for a rejuvenating agent, anti-strip requirements, and possible use in a hot recycle mix design.

The tests conducted to determine if a rejuvenating agent would be required included gradation, asphalt content, properties of the asphalt cement recovered by the Abson Method, Marshall stability and flow, air voids, and unit weight. The average results of the tests indicated that the gradation, asphalt content and percent air voids of a 100 percent recycled mix would be within the specification limits for a Type III mix. In addition, the average Marshall stability, flow and % air voids values were excellent; 1689, 12, and 5, respectively. Properties of the asphalt cement recovered from the Abson Method produced an average penetration of 55, and an average Absolute Viscosity of 7,208 poises at 140^{o}F. Such results indicated that a rejuvenating agent would not be required if the material was to be hot or cold recycled.

Since the question of stripping aggregate was of great concern, several tests were conducted on the pavement in its existing condition and in a recycled condition. First of all, crushed pavement, which appeared to be suffering from severe stripping, was subjected to the stripping test (Boiling Method, Vt. A.O.T. - MRD 10-81). No further stripping was evident. Next, crushed pavement was reheated, recoated and then subjected to the same test. Again less than 5 percent stripping was evident, an acceptable level which was repeated again in additional tests.

The evaluation of the material for use as a portion of a hot recycled mix was accomplished utilizing 20, 30, 40, and 50 percent crushed pavement combined with virgin aggregates and new asphalt cement. All mixes were designed within the specification limits for a Type III mix with 6.4 percent asphalt content. A total of eight mixes were designed, produced, and evaluated with the same series of tests that were run on the preliminary pavement samples. The average values obtained indicated that the pavement in question could be hot recycled; either by means of a conventional hot mix plant or by a drum mix plant. The values also indicated that quality mixes could be produced utilizing any percentage of old pavement material consistent with the type of plant used. The average stability and percent air voids of the mixes were 898 and 4.1, respectively. The values obtained from testing the recovered asphalt cement indicate that the addition of a 150-200 penetration grade asphalt cement would rejuvenate the old asphalt cement sufficiently. The average Absolute Viscosity and penetration values were 1888 and 85, respectively. Such values were equivalent to a new mix that would be made using an asphalt cement with a penetration in the range of 120 - 140. The results indicated that an 85-100 penetration grade could be used in a recycled mix if increased stability values were desired.

The presence of the rubber slurry interlayer material in the hot recycle mix design test series did not have an adverse effect on mix values. Additional testing revealed negative effects on mix stability, air voids, and flow values only when excessive amounts of rubber were added to a variety of recycle mixtures. The amount of rubber present in the existing pavement would not be detrimental to a recycled mix under normal conditions.

The removal of the pavement was accomplished to an average depth of 3 1/2 inches in 2 passes utilizing a Barber-Greene RX-75 Dynaplane and a CMI PR 375 Rotomill. The majority of the reclaimed pavement consisted of both Type II and Type III mixes placed in two courses totaling three inches in thickness. An estimated 15 percent of the material consisted of Type III mix placed as the original surface course of pavement in 1964. The latter material was obtained in the process of insuring that all of the SRI was removed.

The cold planing method of reclaiming the pavement in thin lifts produced a very uniform gradation with less than 10 percent of the material exceeding a maximum size of 1½ inches. An estimated 11,000 tons of material was stockpiled at the batch plant site. All material was covered with plastic sheeting which in turn was held in place with used tires. The treatment was successful in preventing moisture intrusion as evidenced by recorded moisture contents averaging 1/2 to 1 percent. The pavement millings did not fuse together to any serious degree while stockpiled up to 12 feet in height with ambient temperatures ranging up to 95^{O}F.

MIX DESIGNS AND TESTING

The contractor developed mix designs utilizing 30, 35, and 40 percent reclaimed material. All designs met the specification for Item 406 and thus were conditionally approved by the Agency pending satisfactory trial drops. The asphalt used was an 85-100 penetration grade supplied by British Petroleum, Montreal, Quebec. Coarse aggregate was obtained from Pike's New Haven Quarry while fine aggregate included two sources, Hinesburg Sand & Gravel and the Thibault Pit in Colchester. Due to an average of 9 percent minus 200 sieve material in the extracted pavement millings, a combination of washed and screened sands were used in the recycled mix to comply with the 2-5 percent gradation limit on the 200 sieve size.

Following a days production of recycled mix for private paving contractors, trial drops were taken of 30 and 40 percent recycled mix on July 1 & 2, 1981. The 30 percent type III and type IV mixes passed and were approved while the 40 percent recycle failed on low air voids. Two additional trial drops of 40 percent mix failed on gradation and low air voids and consequently the mix was never produced. A total of 17,438 tons of the 30 percent recycled mix was produced. A trial drop with 35 percent recycled material was approved late in the project and 333 tons of material was placed.

Early in the production stage, the recycled mix was tested for recovered penetration values and for resistance to stripping using the immersion-compression test procedure. The recovered penetrations ranged from 55 to 65 with an average value of 59.5. The values were considered high enough so that no rejuvenating agent or softer grade of asphalt was specified.

The immersion-compression tests revealed retained strengths ranging from 101 to 109 percent. Such values indicated the mix was not susceptible to stripping, thereby confirming earlier results which indicated that an antistripping additive was not required.

Daily testing was carried out by a State plant inspector who checked the mix for asphalt content, gradation, air void content, stability, flow, and unit weight. A total of 49 tests were conducted during the 20 days of production with 41 tests passing. Of the 8 failing tests, one was for low air voids and the rest involved gradation deficiencies, mainly on the No. 8 and No. 16 sieves. The more significant differences between the regular and recycled mixes involved percent air voids, flow, and stability values. Percent air voids averaged 4.25 percent with the regular mix and decreased to a low of 2.70 with 35 percent recycled mix. Flow values increased from 8 with the regular mix to 12.5 with 35 percent recycled mix. The stability values increased from 908 pounds for the regular mix to 1400 pounds for 30 percent recycle and 1505 pounds for 35 percent recycle. A summary of the mix properties can be seen in Table 1 on page 11.

TABLE 1

PROPERTIES OF THE REGULAR AND RECYCLED TYPE III MIXES

Type Mix	Regular	30% Recycled	35% Recycled
No. of Tests	2	44	2
% Asphalt	6.40	6.24	6.07
% Air Voids	4.25	2.96	2.70
% Voids Filled	77.8	81.5	84.2
Unit Weight	147.3	149.8	150.3
Flow	8	10.3	12.5
Stability, lbs.	908	1400	1505

Figure 3 · Virgin Aggregate Stockpiles In Foreground
Pavement Millings Covered With Plastic At Center

PLANT MODIFICATION & OPERATION

The recycled bituminous mix was produced at the Pike Industries, Inc. plant located on Avenue A, Griswold Industrial Park in Williston, Vermont. The standard batch plant is a 6 ton model manufactured by Hetherington & Burner (H & B) and is equipped with a baghouse polution control system which was constructed by Pike Industries.

Modification of the conventional plant was required to allow the introduction of the reclaimed pavement millings at the proper point within the production process. The method selected was the use of an HMT 24 Flow-boy Asphalt Transport body combined with an elevator conveyor system which transported the material to a hopper bin mounted on the plant. The plants automated controls introduced the material directly into the weight hopper as required.

Figure 4 Installation of Elevator

During the initial production stage, the millings were transported directly from the stockpile to the Flow-boy by bucket loader without any prior screening. This resulted in occasional clogging of the 5 1/2 inch x 6 1/2 inch grizzly screen mounted on the top of the Flow-boy or in the elevator conveyor system. To eliminate the problem, the millings were pre-screened through a conventional vibratory screening plant where materials over 1 1/2 inches in size were separated. The resulting gradation can be seen in Table 2 on page 16. The 5 to 10 percent oversized material was broken down further by manipulation of the loaders' buckets with the result that less than 5 percent of the millings were discarded.

Figure 5 Removing Oversized Material by Screening

Figure 6 Feeding Reclaimed Material to Weight Hopper

The plant charging sequence consisted of the virgin coarse aggregate followed by the pavement millings with the virgin fine aggregate last. Initially, inspection of the mix in the trucks revealed occasional lumps of the pavement millings which had not broken down completely during the mixing process. Although there was concern that the lumps might cause problems when placed in a thin overlay, none were ever noted on the project which suggests the heat of the mix was sufficient to break down the particles over the longer period of exposure. After the contractor began screening the millings as a standard procedure, fewer lumps were noted although they were never completely eliminated from all of the mix produced.

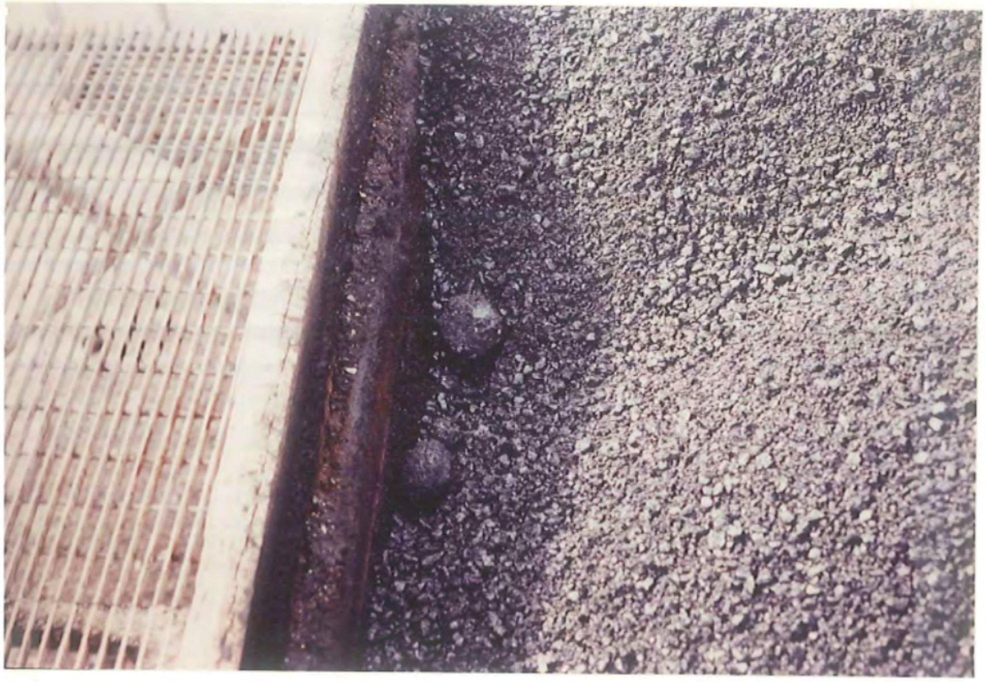


Figure 7 Lumps of Reclaimed Material in New Mix

Initially, the temperature of the virgin aggregate and sand was raised from the normal $300^{o}F\pm$ range to an average of $450^{o}F$ to compensate for the introduction of the "ambient" pavement millings which contained 1/2 to 1 percent moisture. This was found to be higher than necessary and was lowered to $390^{o}F$. Further adjustments were made as the project progressed with the result that the virgin materials were heated to a 380^{o} to $390^{o}F$ range in the morning and an average of $360^{o}F$ at midday and later. A check of each test load by the plant inspector revealed a range of $275^{o}F$ to $310^{o}F$ with an average temperature of $295.5^{o}F$. This temperature was within the $290^{o} \pm 20^{o}F$ range prescribed for the 85-100 penetration grade asphalt and could have been lowered even more but the producer chose not to since production and placement of the mix was progressing satisfactorily.

Production of the recycled mix was somewhat slower than the standard mix but always met the needs of the paving crew. The plant had a theoretical maximum production rate of 6 tons per minute while its normal operating rate was 4.5 tons per minute or 270 tons per hour. Conditions which slowed the production of the recycled mix included the time required to charge the weigh hopper with the pavement millings, and the increase in dry and wet mixing cycles from 6 and 36 seconds to 10 and 50 seconds respectively. As a result, each 4.5 ton batch took approximately 90 seconds for an overall production rate of 180 tons per hour.

A total of 17,807.2 tons of recycled mix were produced in 20 working days. In excess of 1000 tons per day were produced on 6 of the days with the highest daily production reaching 1388 tons.

TABLE 2

GRADATION OF PAVEMENT MILLINGS AFTER SCREENING

Sieve Size	Percent Passing	Range
1 1/2 in.	100	
1 in.	90	87-94
3/4 in.	86	84-90
1/2 in.	76	73-83
3/8 in..	66	61-72
4	42	36-45
8	20	17-22
16	8	7-8
30	3	2-3
50	1	
200	0	

PAVING OPERATION AND FIELD TESTING

Field paving on Vermont Rte. 15 began with the placement of a leveling course on July 6th. All paving was completed 20 working days later on August 10, 1981. Weather conditions were generally good while paving although rain did cancel or postpone the operation on 6 different days. Daytime ambient temperatures ranged from 63°F to 92°F with an average temperature of 80°F.

A leveling course of Type III mix was placed at an average thickness of 15/16 inches over approximately 85 percent of the project. The surface course, also consisting of Type II mix, averaged 1 1/8 inches in thickness. Placement was made with a PF-180H rubber tired Blaw-Knox paver. Initial compaction was obtained with an 8 - 10 ton double axle steel wheeled roller while final compaction was obtained with a 12 - 15 ton triple axle steel wheeled roller. A 20 - 25 ton rubber tired roller was also used for intermediate compaction on the leveling course.

The recycled mix did not present any significant problems in placement. Occasionally an oversized coarse aggregate or other foreign object such as a broken tooth from the cold planing equipment would show up in the mix. When a thin lift was being placed, such objects would drag beneath the pavers screed resulting in the need for hand work to correct the area.

The paving crew was quick to notice that the recycled mix was somewhat stiffer than virgin mix. This condition made hand work more difficult but overall the crew preferred working with the recycled mix. The increased stiffness of the mix also made it less susceptible to shoving under initial compaction. Rubber shreds recovered with the pavement millings were visible in the surface of the pavement but did not cause any known problems.

On several occasions some project personnel expressed a concern that the fresh pavement appeared to be flushing slightly. They felt the condition might have been caused by the fact that the recycled mix ran on the low side of the 2 - 5 percent air void limit. Other individuals felt the condition was the result of allowing traffic on the surface before the temperature had cooled down, a procedure made necessary to allow one-way traffic on the highway. In some localized areas, the appearance of flushing may have been due to vehicles trucking asphalt emulsion from the tack coat onto the new pavement. A single load of 25 percent recycled mix was placed but since it did not produce a different appearance, production of 30 percent recycled mix was continued.

Field observations included recording information on the material placed on the 10 test sections and identifying the locations of all loads of mix that were sampled and tested at the plant laboratory. The test load locations were cored at a later date and the bulk specific gravity of the cores were compared with the plant bulk specific gravities for the same loads with an average compaction ratio of 97.8 percent resulting. The cores averaged 95.3 percent of theoritical maximum density.

POST CONSTRUCTION OBSERVATIONS

In August, 1981, approximately 2 1/2 weeks after paving was completed, pavement distress was observed on a section of the westbound lane in the Village of Jericho, milemarker 0063±. Roadway alignment and gradient in the area would require braking of vehicles traveling at the posted speed or greater. The distress was in the form of slippage or shoving with the result that the underlying pavement could be viewed at several crack locations. The most serious location was repaired in early September by removing the pavement and patching a 6 1/2 foot by 19 foot area. A detailed inspection in October revealed 4 areas with minor to moderate shoving or cracking covering approximately 77 lineal feet of roadway. All of the affected areas except one were Type IV recycled mix which was placed on July 14, 1981, at a prescribed thickness of 1 inch to accomodate drives and sidewalks in the area. Field notes taken while paving the area in question, revealed that it began raining at 8:05 that morning and the project was shut down 10 minutes later due to the weather. Although an asphalt emulsion tack coat was applied, it is possible that some of it was diluted or washed away with the rain prior to the placement of the overlay. In addition, the rain which fell on the last load before rolling was completed, may have had some effect on the material's stability. One area of distress was noted approximately 100 feet east of a transverse paving joint indicating it occurred in recycled mix which was placed the following day. Neither loss of tack coat or rain would have been involved with the problem at this area. Cores taken adjacent to distressed areas disclosed pavement thickness of 11/16 to 13/16 inches.

On September 4, 1981, friction tests were taken on the project area by Federal Highway Administration and State personnel using a locked wheel friction trailer under the control of the Region 15, Demonstration Projects Division. The measurements, taken in the left wheel path at a speed of 40 mph, averaged 37.2 for the project. Friction values on the westerly half of the project averaged 34.2. Such readings show the effect of the 2 1/4 times higher traffic volumes on that portion of the project when compared with the easterly half of the project where friction values averaged 40.7. The variations in traffic volumes made it impractical to compare minor differences in friction values between the standard and recycled mixes.

The riding quality of the pavement was checked with a Mays Ride Meter on October 21, 1981. The surface tolerance in inches of roughness per mile averaged 15.06 inches on the eastbound lane and 17.52 inches on the westbound lane. Such readings are excellent and credit should be given to the mix produced, the paving crew, and the State personnel on the project. There were no significant differences in roughness between areas paved with recycled or standard mix.

An inspection of the project on January 28, 1982, revealed little change in the areas with pavement distortion with the exception of an increase in the length of one irregular longitudinal crack from 7 to 21 feet. Inspection of the 10 test sections revealed that 3 of the 5 full width transverse cracks in the old pavement had reflected up through the new overlay. Although 94 percent of the cracks in the old pavement were longitudinal or miscellaneous, only 17 feet of the cracks had reflected through the overlay. The riding quality of the pavement was still very good at the time of the inspection.

ENERGY AND COST ANALYSIS

The energy consumed in the production of the recycled bituminous mix was less than that required to produce a conventional mix. Savings in the manufacture and haul of asphalt cement, crushed stone, and fine aggregate amounted to 86,370 BTU/Ton of 30 percent recycled mix and 112,590 BTU/Ton of 35 percent recycled mix. The amount of energy required to operate the hot mix plant was the same with the regular and recycled mixes averaging 1.58 gallons of number 4 fuel oil per ton of mix. The requirement for higher virgin aggregate temperatures for the purpose of heat transfer was apparently balanced by the fact that the pavement millings were low in moisture content and did not require heating.

The only additional energy consumed with the recycling operation involved screening of the pavement millings at an energy cost of 2000 BTU/Ton.

Energy savings with recycling totaled 1,536,483,610 BTU for the project. This savings is equivalent to the amount of energy required to heat 15 homes in Vermont for one energy year.

Bituminous Concrete Pavement, Item 406.25, was bid at a unit price of $31.90 per ton which included the furnishing, mixing, hauling and placing of the bituminous mix and the furnishing of signs, labor, tools, equipment, flagmen, and incidentals necessary to complete the work. Since hot recycling had not been attempted previously in Vermont, and some modifications were required on the batch plant, no reduction in the unit price was requested when the Agency approved the use of reclaimed pavement in the mix. Based upon the success of the mix production and the energy and resource savings attained, cost savings would seem appropriate on future hot recycle projects.

CONSERVATION OF NATURAL RESOURCES

The use of 30 percent reclaimed pavement reduced the coarse aggregate requirement by 343 pounds per ton of mix, the fine aggregate requirement by 194 pounds, and the asphalt requirement by 37 pounds per ton of mix. Savings with the 35 percent recycled mix amounted to 398 pounds of coarse aggregate, 230 pounds of fine aggregate and 43 pounds of asphalt per ton of mix. Total savings for the project amounted to 3063 tons of coarse aggregate, 1733 tons of fine aggregate, and 330 tons of asphalt cement.

ENVIRONMENTAL CONSIDERATIONS

Visual emissions were kept to a minimum on the project and therefore air quality tests were not performed during the production of the recycled mix. As a rule, emissions were limited to the area of the pug mill and were similar to that occurring with the production of a virgin mix. Exceptions did occur when rain showers increased the moisture content of the pavement millings along the face of the stockpile. This resulted in venting of steam and some accompanying dust when the millings were mixed with the hot virgin aggregate. Less dust was produced in transporting the pavement millings from the stockpile to the point of use than that which occurred transporting the virgin aggregate.

Figure 8 Normal Emissions At Pug Mill During Dry Mix Cycle

Figure 9 Maximum Emissions At Pug Mill Due To Venting Of Steam

SUMMARY AND CONCLUSIONS

Vermont's first hot recycling project was successful from the standpoint of production and construction. In general, the following observations and conclusions can be drawn from the project:

The recovery of the reclaimed pavement with cold planing equipment resulted in a uniform gradation with less than 10 percent of the material exceeding a maximum size of 1 1/2 inches.

The pavement millings did not consolidate or fuse together in covered stockpiles up to 12 feet in height over a period of one to three months at ambient temperatures up to 95^{o}F.

Penetration values of the asphalt in the recycled mix were considered satisfactory without adding a rejuvenating agent or specifying a higher penetration grade of asphalt cement.

Mixes utilizing up to 35 percent reclaimed material were produced within the specification without difficulty. Mixes with 40 percent reclaimed material failed in trial drops due to low air voids or an excess of fines.

Relatively few plant modifications were required to produce recycled bituminous mix in a conventional batch plant.

Occasional lumps of pavement millings were observed in the trucks following batching but were never noted on the project which suggests the heat of the mix was sufficient to break down the particles over the longer period of exposure.

Production of the recycled mix, although somewhat slower than standard mix, was always sufficient to meet the needs of the paving crew. Production rates often exceeded 1000 tons per day.

The recycled mix did not present any problems with placement although it was somewhat stiffer than virgin mix making handwork more difficult. The increased stiffness made it less susceptible to shoving under initial compaction.

Post construction distress which occurred at 4 locations within a 500 foot section of the westbound lane was believed due to a combination of rain diluting the asphalt emulsion tack coat, thinness of the overlay (3/4" average), and alignment and gradient in the area which would require braking of vehicles.

The friction values of the recycled pavement were silimar to those of a conventional mix.

The riding quality of the pavement was excellent averaging 15 to 17.5 inches of roughness per mile when checked with a Mays Ride Meter.

Energy requirements for plant production were the same for the recycled and standard mixes averaging 1.58 gallons of No. 4 fuel oil per ton of mix.

The use of reclaimed material resulted in energy savings of 86,370 BTU per ton of 30 percent recycled mix and 112,590 BTU per ton of 35 percent recycled mix. Energy savings for the project totaled 1,536,483,610 BTU.

Bid prices should result in cost savings to the State on future hot recycle projects.

The use of reclaimed pavement in the mix resulted in the conservation of 3063 tons of coarse aggregate, 1733 tons of fine aggregate, and 330 tons of asphalt cement.

Production of the recycled mix did not significantly reduce air quality at the plant site.

RECOMMENDATIONS

Based upon the experiences and results obtained on this project, the use of hot recycling should be encouraged whenever practical on future paving contracts.

The recycled and standard pavements should be monitored closely for a period of years to determine and compare the aging characteristics and performance of both materials.

APPENDIX A

WORK PLAN FOR
CATEGORY III EXPERIMENTAL PROJECT

RECYCLING ASPHALT PAVEMENTS

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

WORK PLAN FOR
CATEGORY III EXPERIMENTAL PROJECT

RECYCLING ASPHALT PAVEMENTS
(REGION 15-DEMONSTRATION PROJECT NO. 39)
WORK PLAN 81-B&R-11

OBJECT OF EXPERIMENT

To utilize pulverized bituminous pavement as a portion of a new bituminous concrete mix and to compare the design, manufacturing process, cost, energy consumption, environmental features and performance of the recycled material with a standard bituminous concrete mix.

PROJECT

Essex - Jericho - Underhill FR 030-1(11)

PROJECT LOCATION

Section I - Beginning on Vt. 15 in the Town of Essex, at the Essex Junction East Village limits, and extending northeasterly 1.27 miles to the intersection with TH 702.

Section II - Beginning on Vt. 15 in the Town of Essex, 600 feet east of the Sand Hill Road intersection, and extending northeasterly through the Town of Jericho into the Town of Underhill, a distance of 10.52 miles, ending at the TH 9 intersection at MM 4.35.

EXPERIMENTAL WORK LOCATION

For the full length of the project, a distance of 11.79 miles which shall include a control section.

CONSTRUCTION PROCEDURE

The process shall include mixing the pulverized pavement with new aggregate and asphalt cement in a suitable mixing plant, and placing the recycled mixture and a control section of standard bituminous concrete mix.

INVESTIGATION PROCEDURE

The investigation will include the following steps:

1) Obtain initial design, construction and maintenance records on the section of highway which is to be overlaid.

2) Visually inspect and document the condition of the existing pavement.

3) Analyze samples of the pulverized pavement to determine the properties of the recoverable materials. Document the design test results and analysis of the properties of the recycled design mix and the individual components of the mix.

4) Observe the recycling process and document pertinent information on the equipment modifications required, method of production and production rates, mix temperatures, compaction effort required and achieved, weather conditions, and other related information.

5) Document field tests taken during the construction of the project and obtain core samples of the recycled pavement for lab analysis.

6) Determine if the recycling process provides significant environmental benefits such as elimination of disposal problems, conservation of quality aggregates, etc.

7) Compare differences in energy consumption between the recycled mix and the standard bituminous concrete mix placed on the control section.

8) Compare the cost of the recycled pavement with that of the standard pavement placed on the control section.

9) Compare the performance of the recycled pavement with that of the standard pavement placed on the control section.

CONTROL SECTION

A control section approximately 0.25 miles in length shall be included on the project with the control treatment consisting of a standard bituminous concrete mix placed as a 1/2 inch leveling course and a 1 1/2 inch wearing course. Sufficient data will be gathered on the control section to make the desired comparisons with the recycled pavement section.

COST

The in place cost of the recycled bituminous mix shall be $31.90 per ton.

DATE OF CONSTRUCTION

The experimental treatment shall be completed prior to September 1, 1981.

DURATION OF STUDY

The experimental project will be evaluated for a minimum of three years following completion of construction.

SURVEILLANCE

The experimental and control treatments shall be monitored during construction and at least once each winter and spring for the duration of the study. Evaluations shall include documentation of the condition of both experimental and control treatments.

REPORTS

An initial report covering the basic data collected, construction experiences, test results and initial observations shall be submitted within 90 days after project completion. Interim reports shall be made on an annual basis. A final report shall include recommendations for use in developing future recycling projects.

Reviewed by:

R. F. Nicholson

R. F. Nicholson, P.E.
Materials & Research Engineer

Date: 6/23/81

Vermont Agency of Transportation
Materials & Research Division
June 22, 1981

APPENDIX B

PAVEMENT CONDITION SUMMARY SHEETS

Vermont Agency of Transportation
Materials & Research Division

CRACK COUNT SUMMARY SHEET

Location & Route Essex-Jericho-Underhill Route 15 Job Number FR 030-1(11)
Experimental Feature Hot Recycle Width of Roadway 22'

Code for Crack Type

Type A = Transverse from shoulder to shoulder
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

Date	Original 6/25/81	1/28/82	/ /	/ /	/ /	/ /	/ /	/ /
Section # 1								
Type A	0	0						
Type B	22	0						
Type C	1450	0						
Type D	56	0						
Total	1528	0						
Avg./100' of roadway	509	0						
Section # 2	6-30-81							
Type A	22	0						
Type B	2	0						
Type C	1280	0						
Type D	0	0						
Total	1304	0						
Avg./100' of roadway	652	0						
Section # 3	6-30-81							
Type A	0	0						
Type B	0	0						
Type C	477	0						
Type D	3	0						
Total	480	0						
Avg./100' of roadway	240	0						
Section # 4	6-30-81							
Type A	0	0						
Type B	0	0						
Type C	1115	10						
Type D	0	0						
Total	1115	10						
Avg./100' of roadway	743	8						

Vermont Agency of Transportation
Materials & Research Division

CRACK COUNT SUMMARY SHEET

Location & Route Essex-Jericho-Underhill Rte. 15 Job Number FR 030-1(11)
Experimental Feature Hot Recycle Width of Roadway 22'

Code for Crack Type

Type A = Transverse from shoulder to shoulder
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

Date	Original 6/30/81	1/28/82	/ /	/ /	/ /	/ /	/ /	/ /
Section # 5								
Type A	0	0						
Type B	39	0						
Type C	348	0						
Type D	5	0						
Total	392	0						
Avg./100' of roadway	261	0						
Section # 6								
Type A	22	22						
Type B	10	0						
Type C	840	0						
Type D	8	0						
Total	880	22						
Avg./100' of roadway	587	15						
Section # 7								
Type A	22	22						
Type B	34	0						
Type C	147	0						
Type D	4	0						
Total	207	22						
Avg./100' of roadway	138	15						
Section # 8								
Type A	22	22						
Type B	13	0						
Type C	607	7						
Type D	0	0						
Total	642	29						
Avg./100' of roadway	428	19						

Vermont Agency of Transportation
Materials & Research Division

CRACK COUNT SUMMARY SHEET

Location & Route: Essex-Jericho-Underhill Rte. 15 — Job Number: FR 030-1(11)
Experimental Feature: Hot Recycle — Width of Roadway: 22'

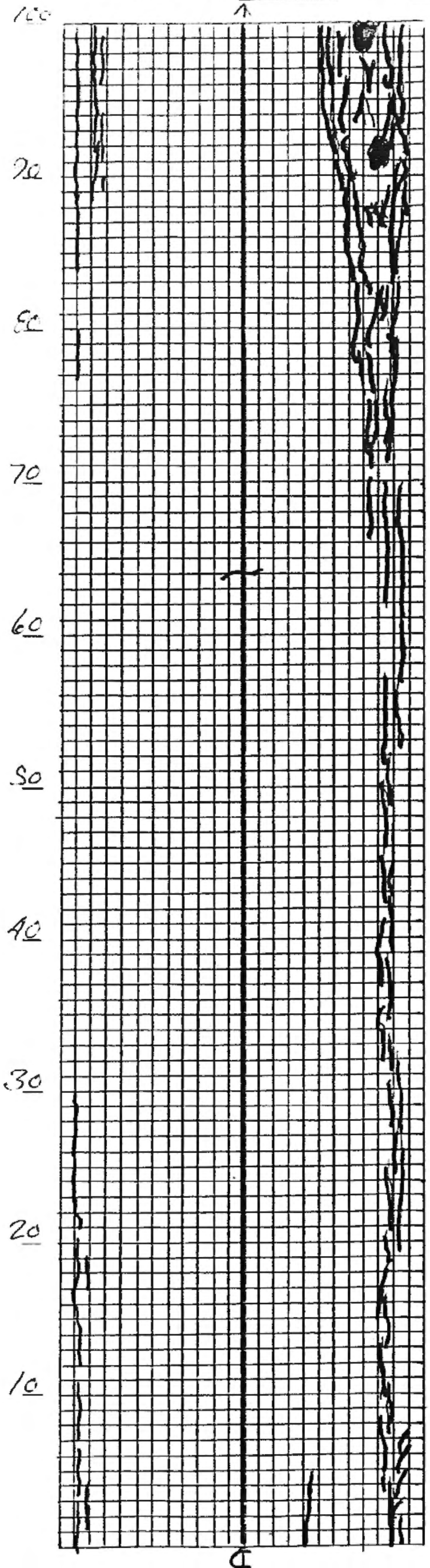
Code for Crack Type

Type A = Transverse from shoulder to shoulder
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

Date	Original 6/30/81	1/28/82	/ /	/ /	/ /	/ /	/ /	/ /
Section # 9								
Type A	0	0						
Type B	16	0						
Type C	228	0						
Type D	0	0						
Total	244	0						
Avg./100' of roadway	163	0						
Section # 10								
Type A	0	0						
Type B	7	0						
Type C	339	0						
Type D	7	0						
Total	353	0						
Avg./100' of roadway	235	0						
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								

APPENDIX C

PAVEMENT CONDITION ON TEST SECTIONS



22.3 ℄ to ℄
22.6 full width

6" elm
63.48
19.80
14" elm

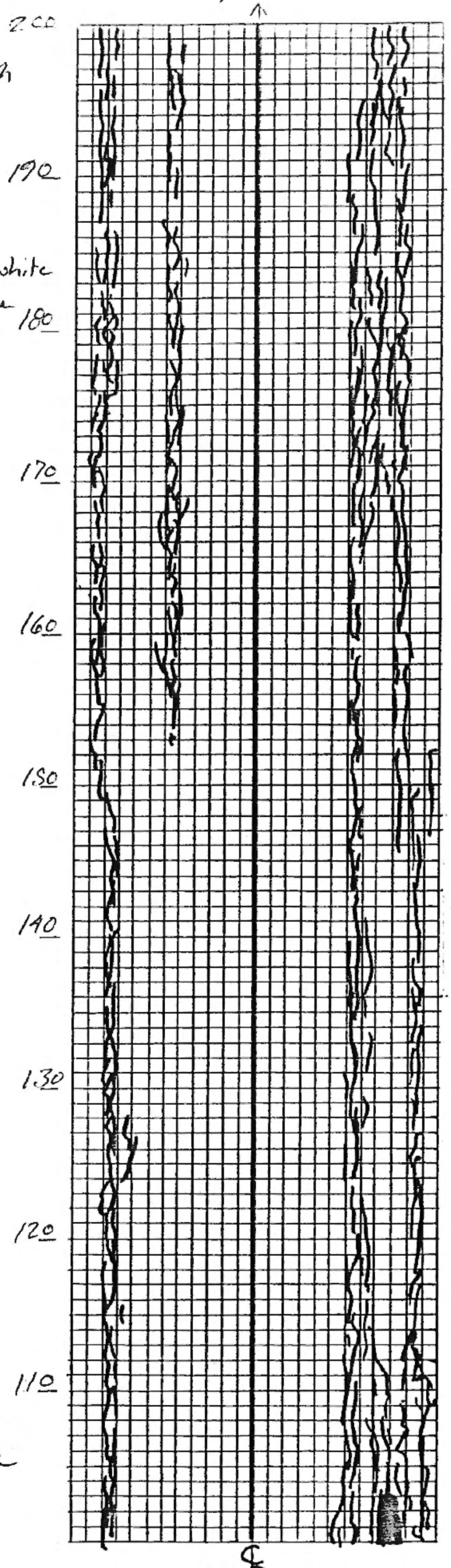
Nail on white
SB Shoulderline

Section #1

mm 0160
0415
0433

RUNS SOUTH

Guard Rail
6.52
5.30 Nail on Shoulder Line

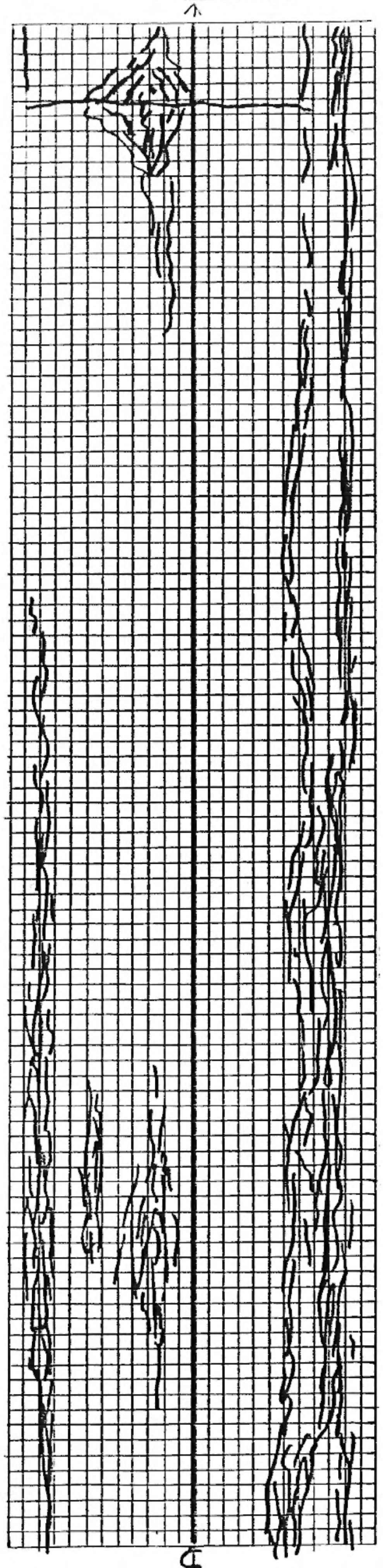


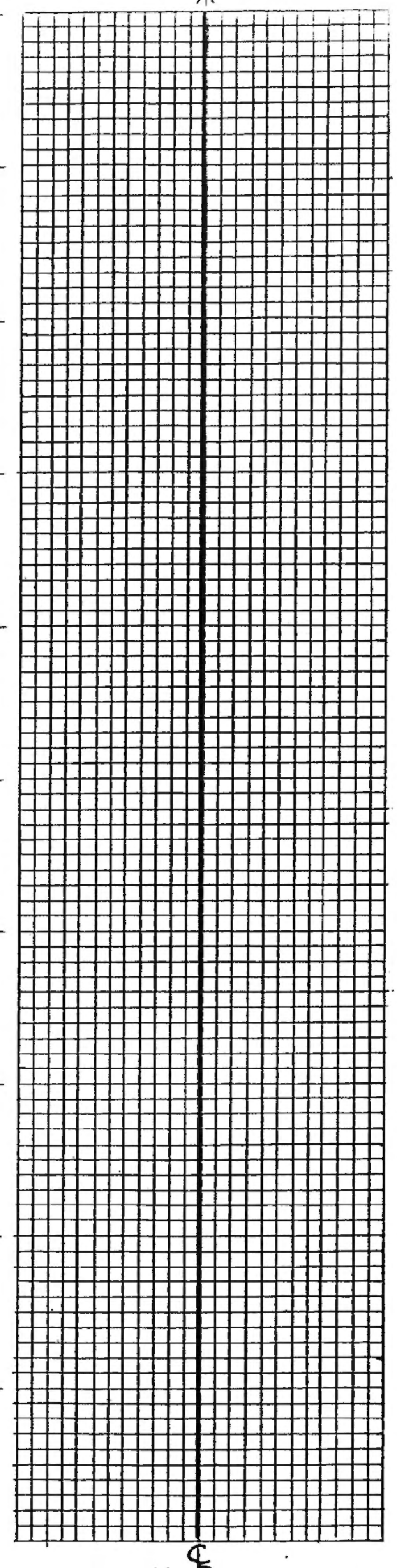
ORIG. SURVEY BY ___ DATE ___ PAVEMENT CONDITION SURVEY SHEET

RE-SURVEYED BY ______ DATE ____ PROJECT FR 030-1 (11)

Section #1

300
290
280
270
260
250
240
230
220
210



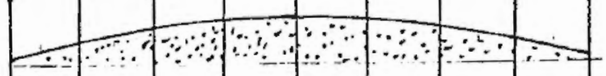


TEST SECTION #1

S BOUND | N BOUND

RUTTING READINGS

PROJECT RTE 15
HOT RECYCLE



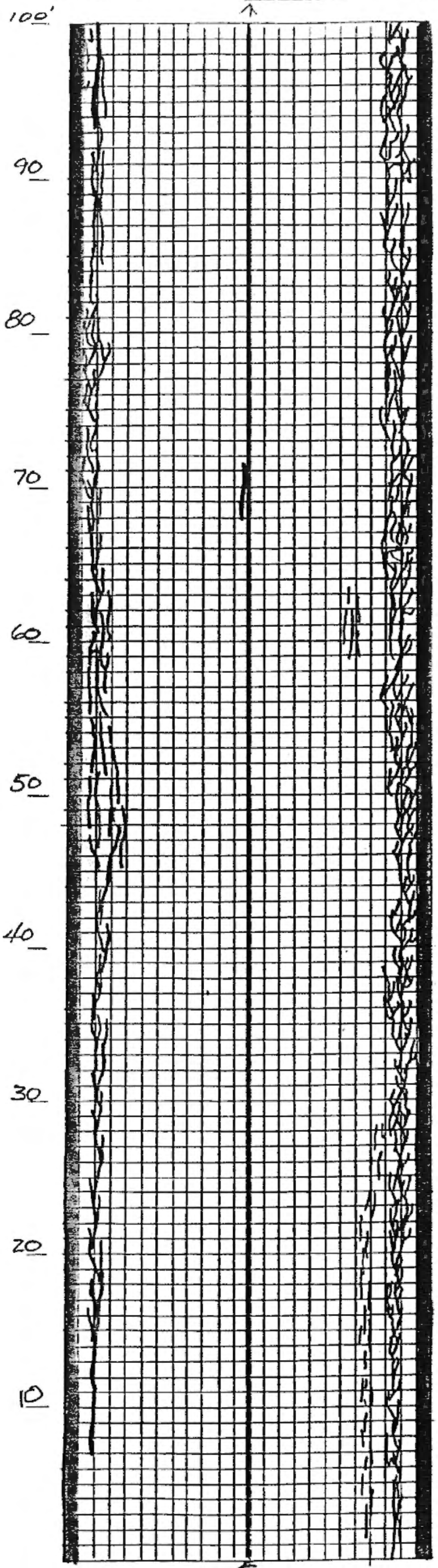
DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/25/81*	0+00	0	4/16	0	2/16	0	3/16	0	5/16	0
	50	0	12/16	0	2/16	0	3/16	0	4/16	0
	100	0	35/16	0	2/16	0	3/16	0	13/16	0
	150	0	20/16	0	7/16	0	3/16	0	20/16	0
	200	0	11/16	0	1/16	0	1/16	0	13/16	0
	250	0	17/16	0	1/16	0	3/16	0	8/16	0
	300	0	6/16	0	4/16	0	3/16	0	8/16	0
10/6/81	200	0	0	0	1/16	0	1/16	0	1/16	0
	250	0	0	0	1/16	0	1/16	0	0	0
	300	0	0	0	1/16	0	0	0	0	0
	SURVEYED 1/28/82 NO CRACKS									

COMMENT

ROADWAY WIDTH 22.7'

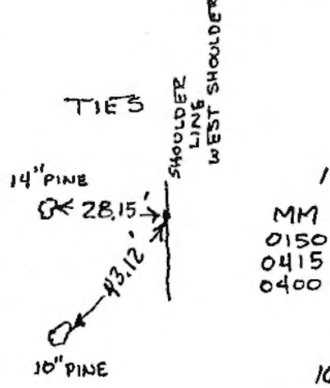
*Original Reading Before Construction

ORIG. SURVEY BY P.C. BM DATE 6/30/81 [illegible] SURVEY SHEET 1 OF 1
RE-SURVEYED BY ______ DATE ____ PROJECT ESSEX-JERICHO-UNDERHILL
FR 020-1(11)



SECTION #2

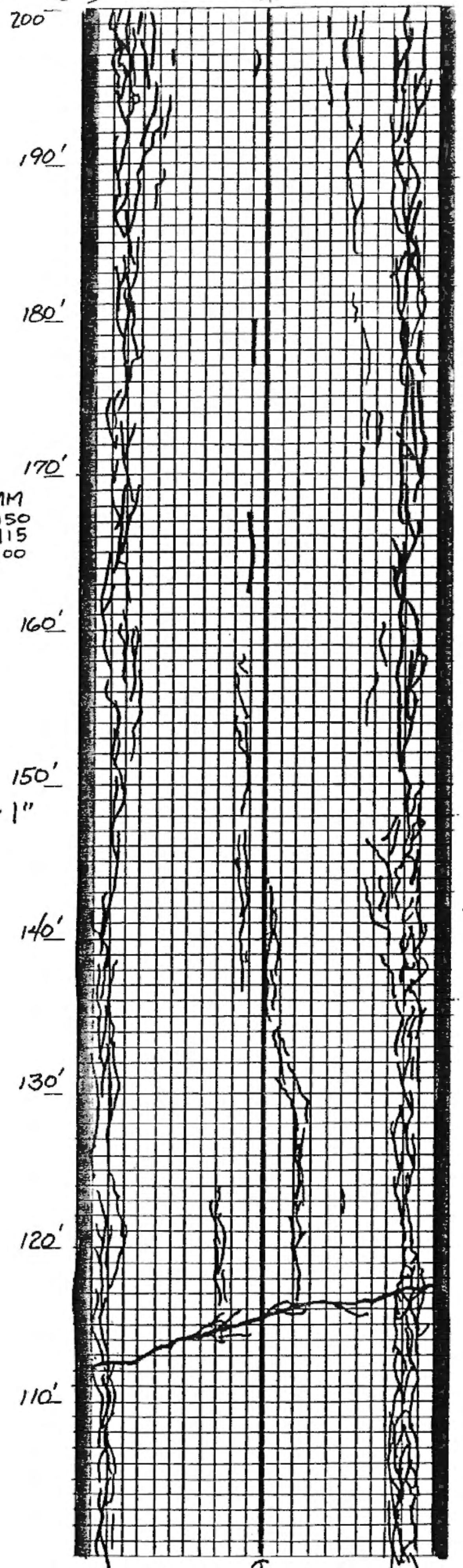
RUNS SOUTH



MM
0150
0415
0400

CRACKS AVG.

1/4" WIDE
RANGE FROM 1/8"~1"



MM
0400

TEST SECTION #2

S BOUND — N BOUND

RUTTING READINGS

PROJECT RTE 15

HOT RECYCLE

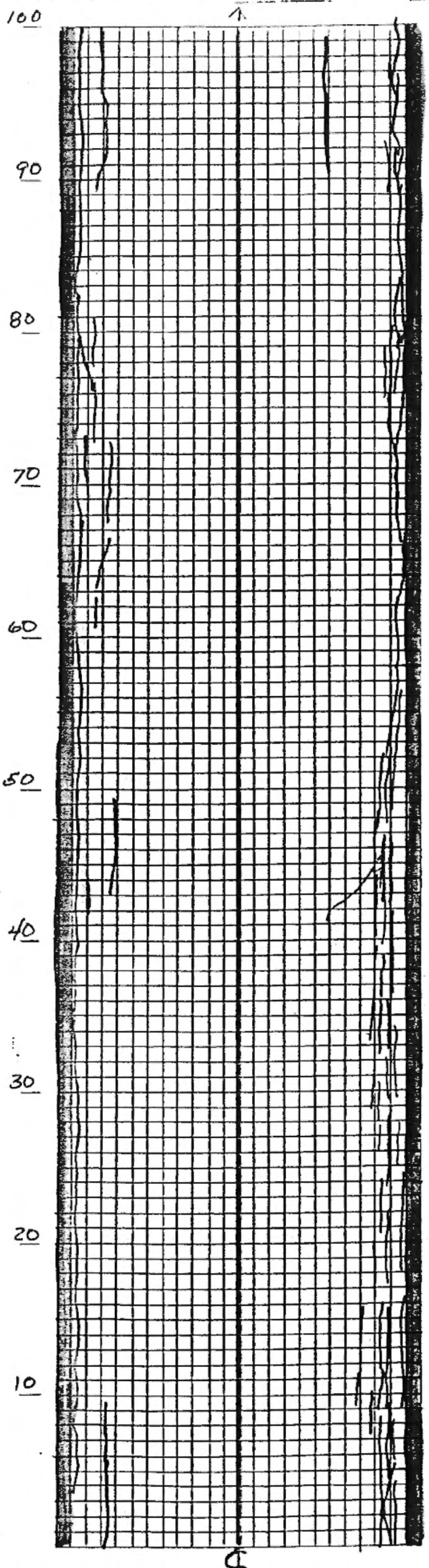
DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81 *	0+00	0	5/16	0	3/16	0	2/16	0	7/16	0
	50'	0	4/16	0	3/16	0	3/16	0	9/16	0
	100'	0	10/16	0	5/16	0	3/16	0	6/16	0
	150'	0	19/16	0	6/16	0	3/16	0	10/16	0
	200'	0	10/16	0	3/16	0	2/16	0	17/16	0
10/6/81	0+00	0	0	0	1/16	0	1/16	0	0	0
	50	0	0	0	1/16	0	0	0	0	0
	100	0	0	0	1/16	0	1/16	0	0	0
	SURVEYED 1/28/82 NO CRACKS									

COMMENT

ROADWAY WIDTH 23'

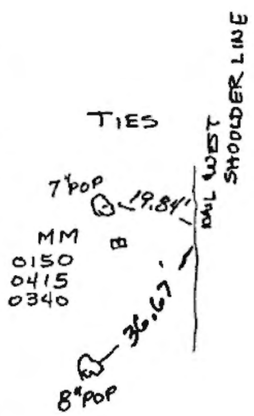
*Original Reading Before Construction

ORIG. [illegible] PC & BM DATE 6/30/81 [illegible]
RE-SURVEYED BY ______ DATE ____ PROJECT ______________

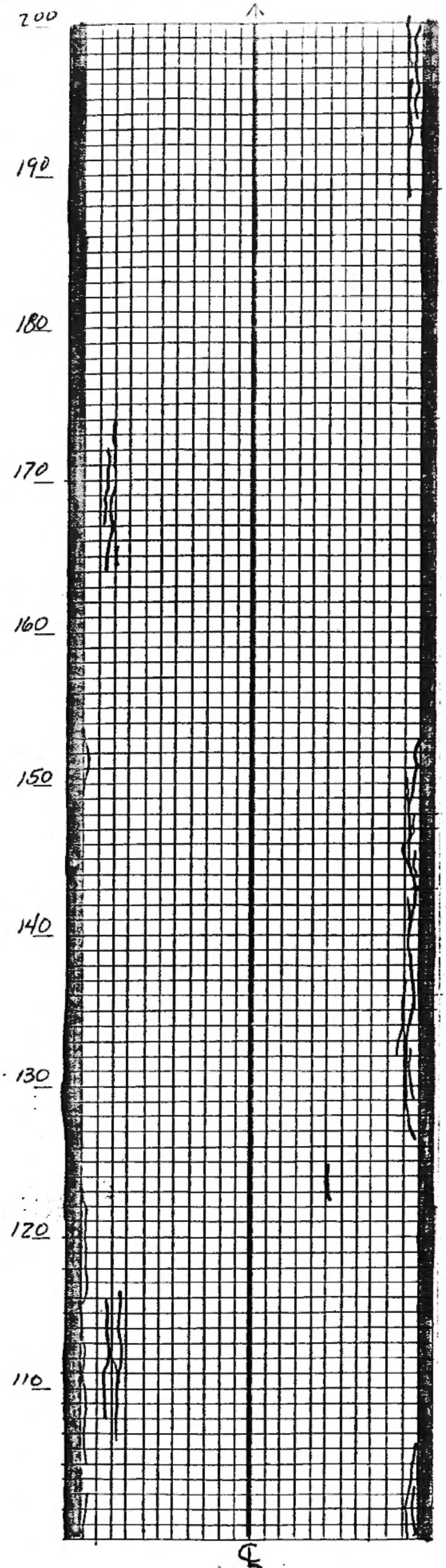


SECTION #3
RUNS SOUTH

TIES



MM
0340



TEST SECTION # 3

S BOUND N BOUND

RUTTING READINGS

PROJECT RTE 15

HOT RECYCLE

DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81 *	0'	0	1/16	0	1/16	0	6/16	0	10/16	0
	50'	0	4/16	0	1/16	0	3/16	0	1/16	0
	100'	0	3/16"	0	2/16	0	3/16	0	5/16	0
	150'	0	1/16	0	2/16	0	4/16	0	5/16	0
	200'	0	0	0	2/16	0	5/16	0	3/16	0
10/6/81	0	0	0	0	0	0	0	0	0	0
	50	0	0	0	1/16	0	0	0	0	0
	100	0	0	0	1/16	0	0	0	0	0
	150	0	0	0	1/16	0	5/16	0	1/16	0
	200	0	0	0	0	0	3/16	2/16	2/16	0
	SURVEYED 1/28/82 NO CRACKS									

COMMENT

CRACKS AVG. 1/8"

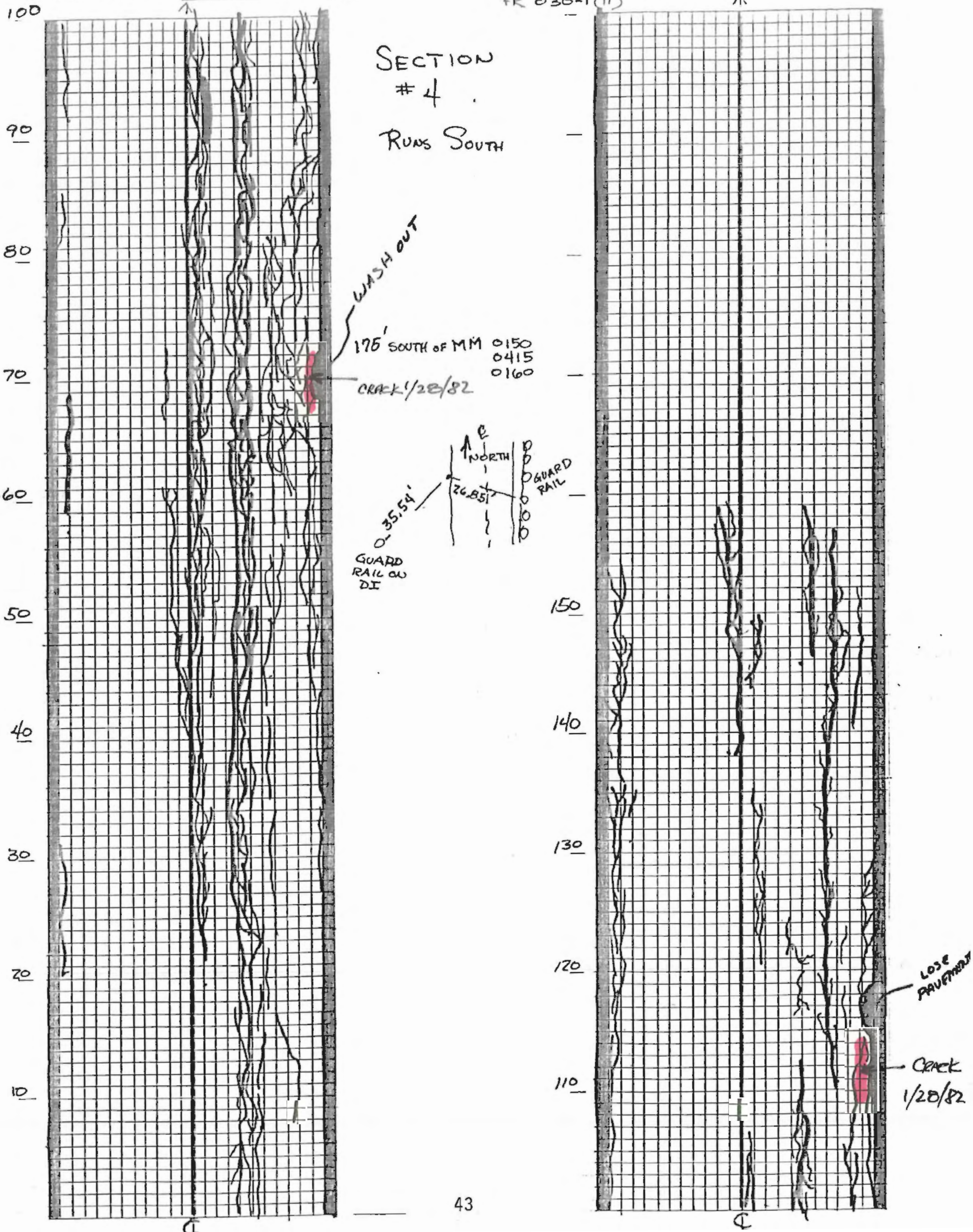
RANGE 1/8" ~ 1/4"

ROADWAY WIDTH 23.3'

℄ TO ℄ = 22.2'

*Original Reading Before Construction

ORIG. SURVEY BY R.C. & BM DATE 6/30/81 PAVEMENT CONDITION SURVEY SHEET 1 OF 1
RE-SURVEYED BY ______ DATE ______ PROJECT ESSEX-JERICHO-UNDERHILL
FR 030-1(11)



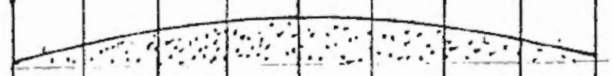
TEST SECTION # 4

S BOUND N BOUND

RUTTING READINGS

PROJECT RTE 15

HOT RECYCLE



DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
*6/30/81	0'	0	14/16	0	3/16	0	5/16	0	3/16	0
	50'	0	29/16	0	14/16	0	3/16	0	4/16	0
	100'	0	26/16	0	10/16	0	4/16	0	2/16	0
	150'	0	20/16	0	9/16	0	7/16	0	5/16	0
10/6/81	0	0	1/16	0	1/16	0	1/16	0	0	0
	50	0	1/16	0	1/16	0	1/16	0	0	0
	100	0	1/16	0	1/16	0	1/16	0	0	0
	SURVEYED 1/28/82 10' of LONGIT. CRACKS									

COMMENT

CRACKS AVG. 3/4" WIDE

RANGE 1/4" ~ 1 3/4"

ROADWAY WIDTH = 23.8'

℄ TO ℄ = 21.7'

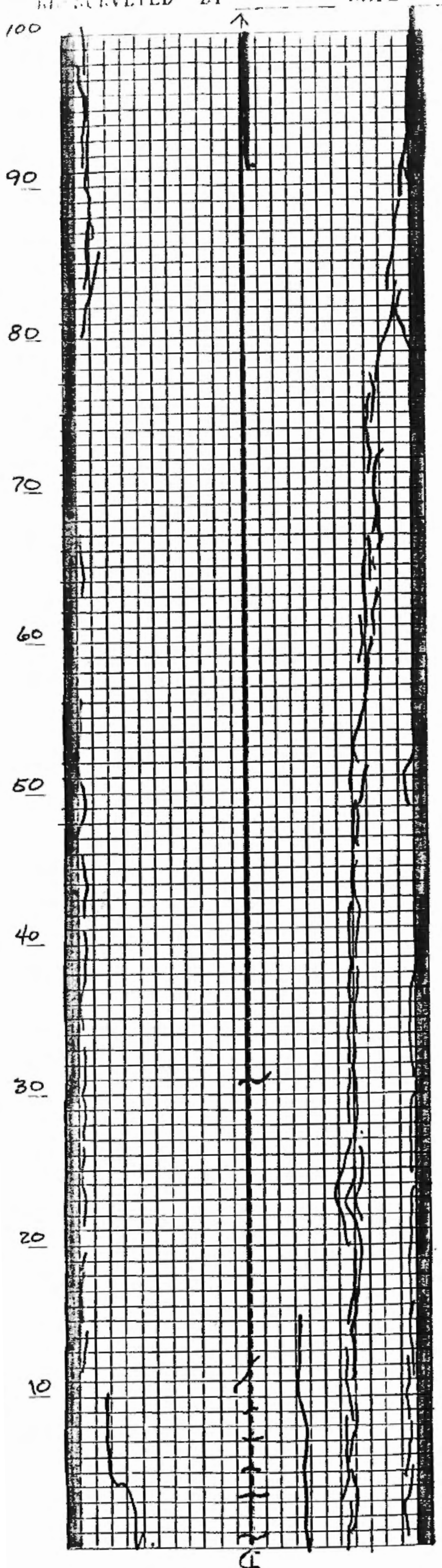
*Original Reading Before Construction

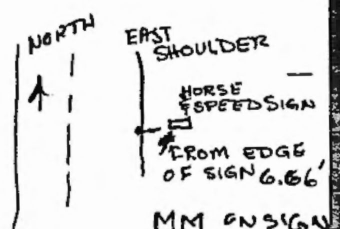
... VEY BY RC. & BM ... 6/26/81 ... CONDITION ...

RESURVEYED BY ______ DATE ______ PROJECT Essex-Jericho-Underhill

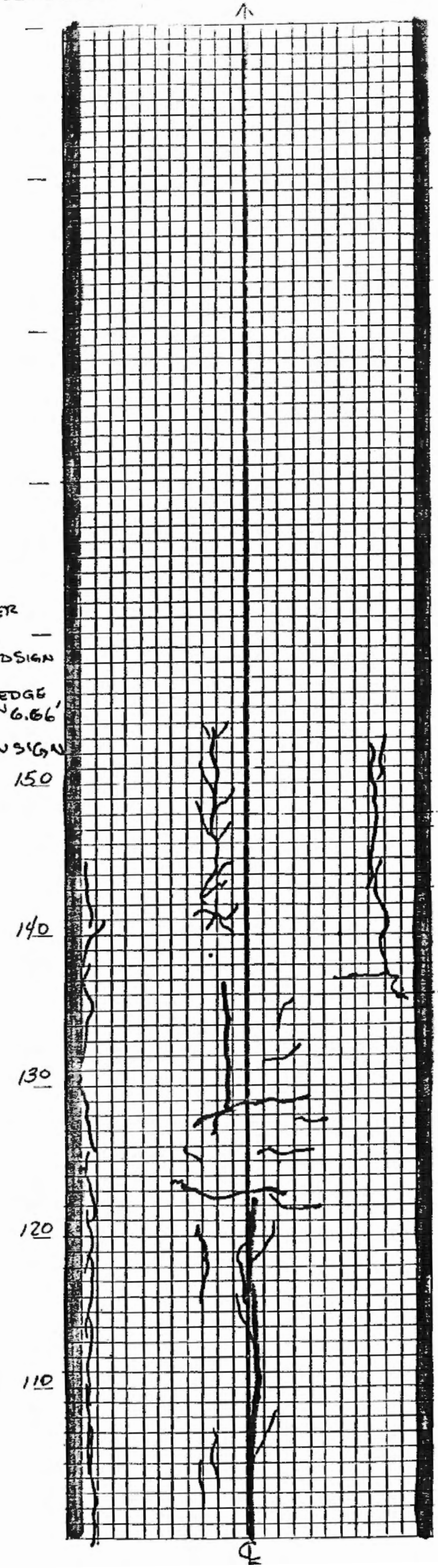
SECTION #5

RUNS NORTH





MM ON SIGN
0150
0415
0020

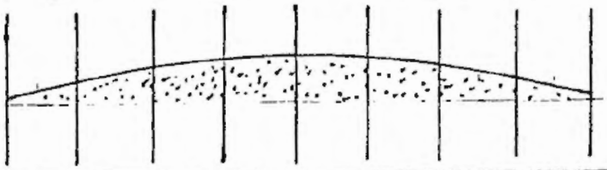


MM
0620

TEST SECTION

RUTTING READINGS

PROJECT RTE 15 HOT RECYCLE



DATE	LOCATION	S BOUND EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		N BOUND WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81 *	0'	0	3/16	0	2/16	0	5/16	0	9/16	0
	50'	0	1/16	0	1/16	0	3/16	0	4/16	0
	100'	0	3/16	0	1/16	0	4/16	0	1/16	0
	150'	0	3/16	0	3/16	0	2/16	0	2/16	0
10/6/81	0	0	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	1/16	0	0	0
	100	0	0	0	1/16	0	2/16	0	0	0
	SURVEYED 1/28/82 NO CRACKS									

COMMENT

Roadway width = 23.3

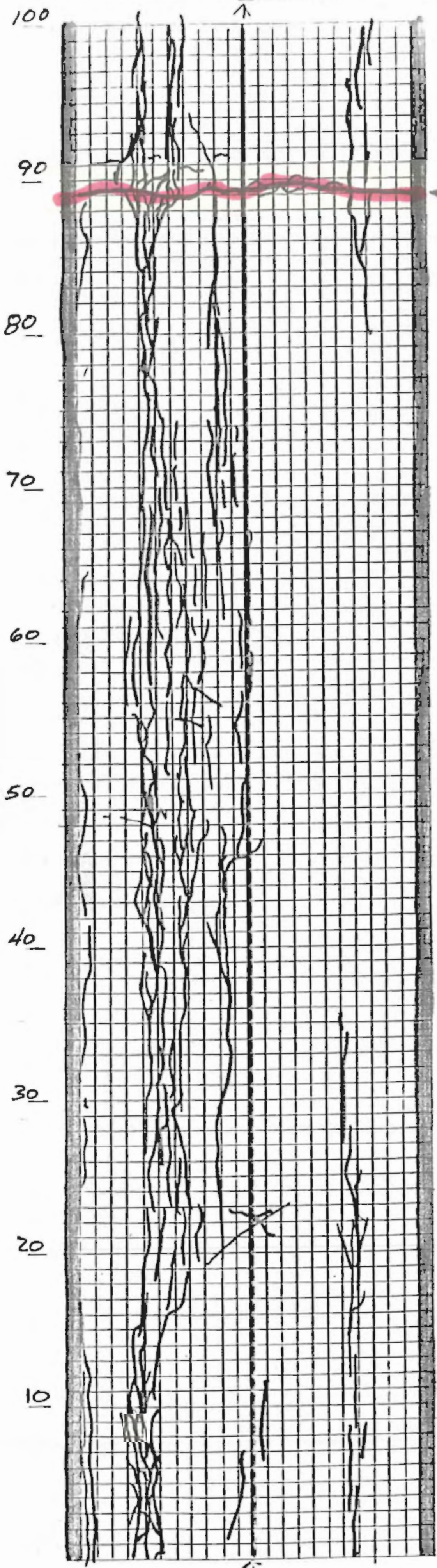
℄ to ℄ = 21.1

Crack avg. 1/4"

Range 1/8" ~ 1/2"

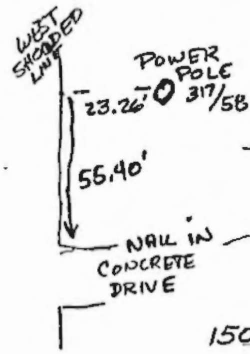
*Original Reading Before Construction

ORIG. SURVEY BY P.C & BM 6/25/81 PAVEMENT CONDITION SURVEY SHEET 1 OF 1
RE-SURVEYED BY ______ DATE ______ PROJECT ______

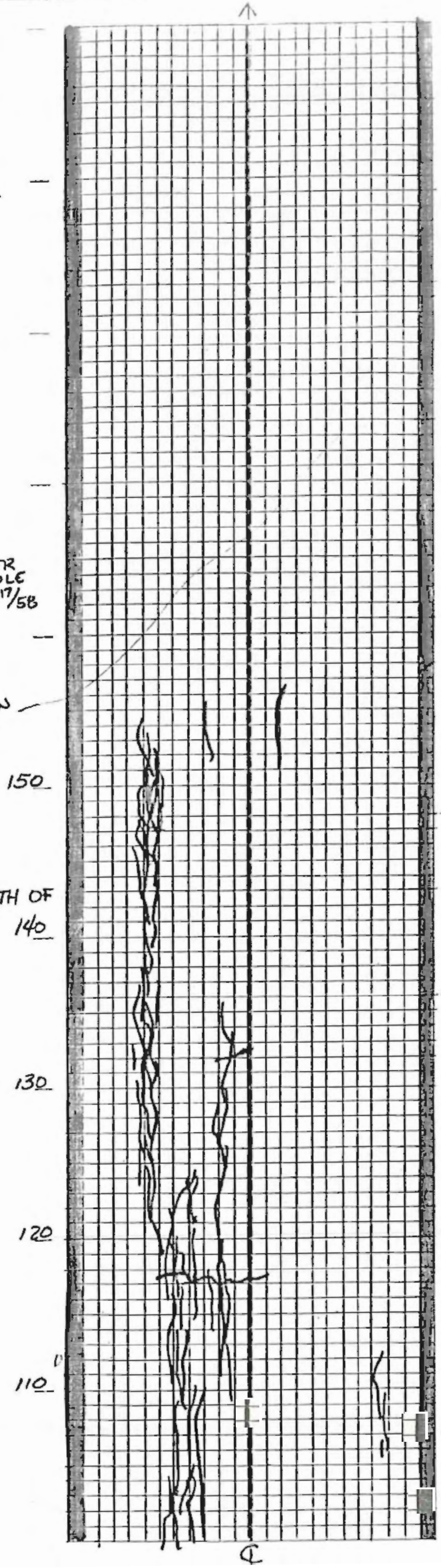


SECTION #6
RUNS SOUTH

← CRACKED 1/28/82



APPROXI. 330' SOUTH OF
MM 0150
0409
0300



TEST SECTION #6

S BOUND N BOUND

RUTTING READINGS

PROJECT RTE 15

HOT RECYCLE

DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81*	0'	0	3/16	0	1/16	0	3/16	0	9/16	0
	50'	0	0	0	1/16	0	2/16	0	4/16	0
	100'	0	5/16	0	1/16	0	1/16	0	2/16	0
	150'	0	3/16	0	1/16	0	1/16	0	1/16	0
10/6/81	0'	0	1/16	0	0	0	1/16	0	1/16	0
	50'	0	0	0	1/16	0	1/16	0	1/16	0
	100'	0	1/16	0	1/16	0	1/16	0	1/16	0
	SURVEYED 1/28/82 (1) 22' TRANSVERSE CRACK									

COMMENT

CRACKS AVG 1/4"

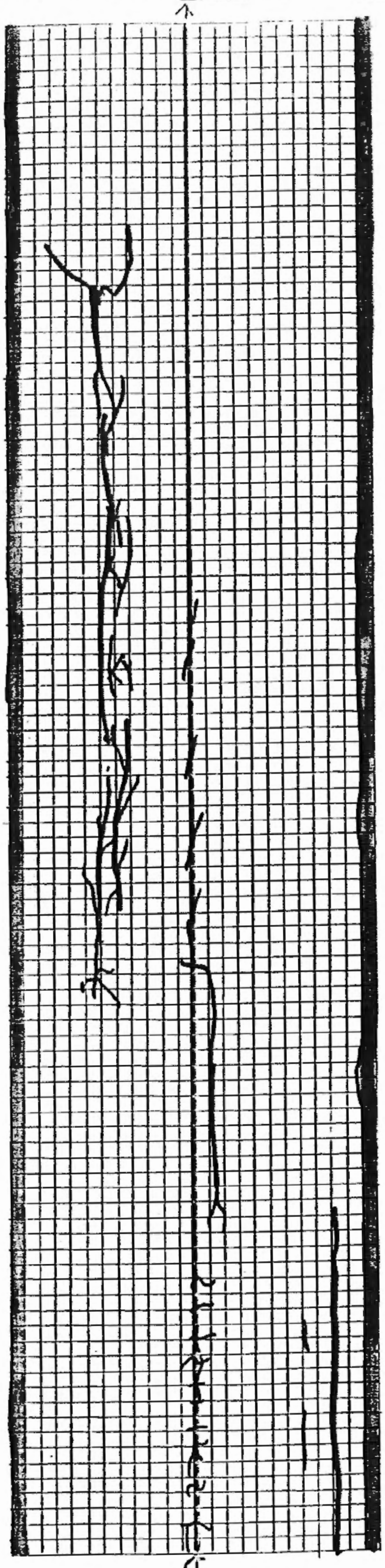
RANGE 1/8 ~ 3/8"

ROADWAY WIDTH = 25.0'

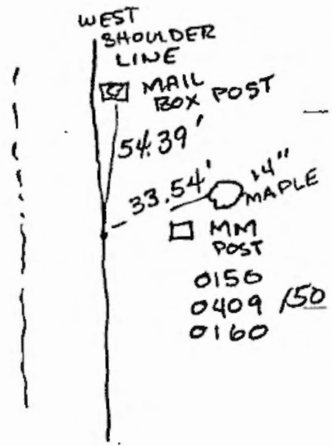
℄ ~ ℄ = 22.8'

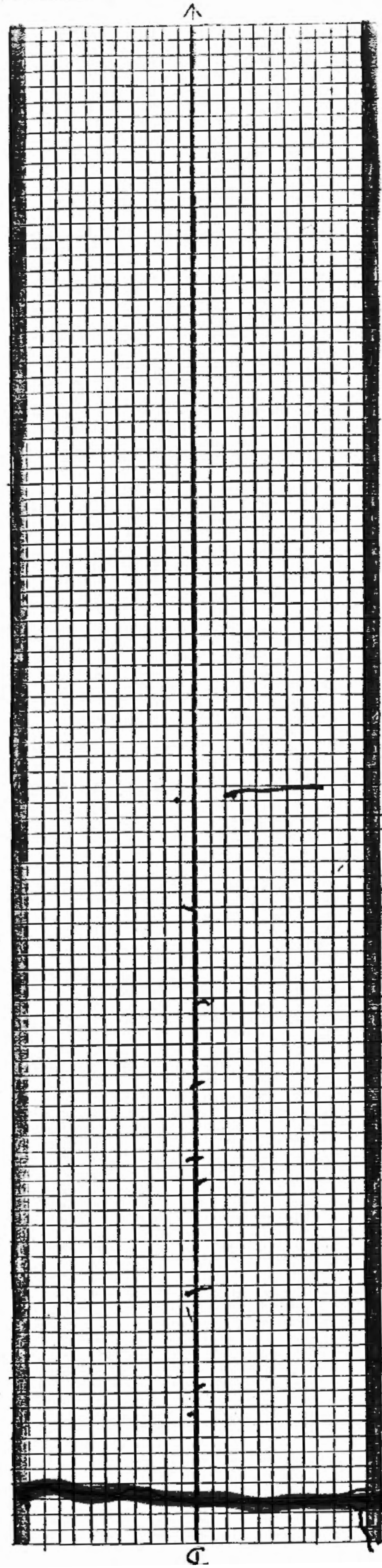
*Original Reading Before Construction

ORIG. SURVEY BY PC & BM DATE 6/30/81 ... PROJECT ESSEX-JERICHO-UNDERHILL SHEET 1 OF 1
RE-SURVEYED BY ________ DATE ____



SECTION #17
RUNS SOUTH





MM
0160

49

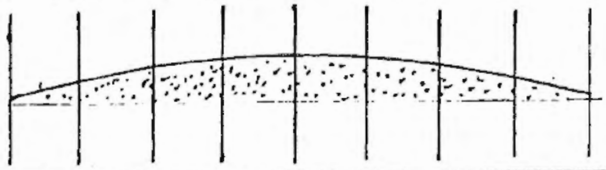
TEST SECTION # 7

S BOUND — N BOUND

RUTTING READINGS

PROJECT RTE 15

HOT RECYCLE



DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81 *	0'	0	2/16	0	5/16	0	4/16	0	5/16	0
	50'	0	0	0	4/16	0	3/16	0	3/16	0
	100'	0	1/16	0	3/16	0	1/16	0	3/16	0
	150'	0	6/16	0	5/16	0	4/16	0	1/16	0
10/6/81	0'	0	0	0	1/16	0	1/16	0	1/16	0
	50'	0	0	0	1/16	0	1/16	0	1/16	0
	100'	0	0	0	1/16	0	1/16	0	1/16	0
	SURVEYED 1/28/82 (1) 22' TRANSVERSE CRACK									

COMMENT

Cracks avg 1/4"

Range 1/8" ~ 3/4"

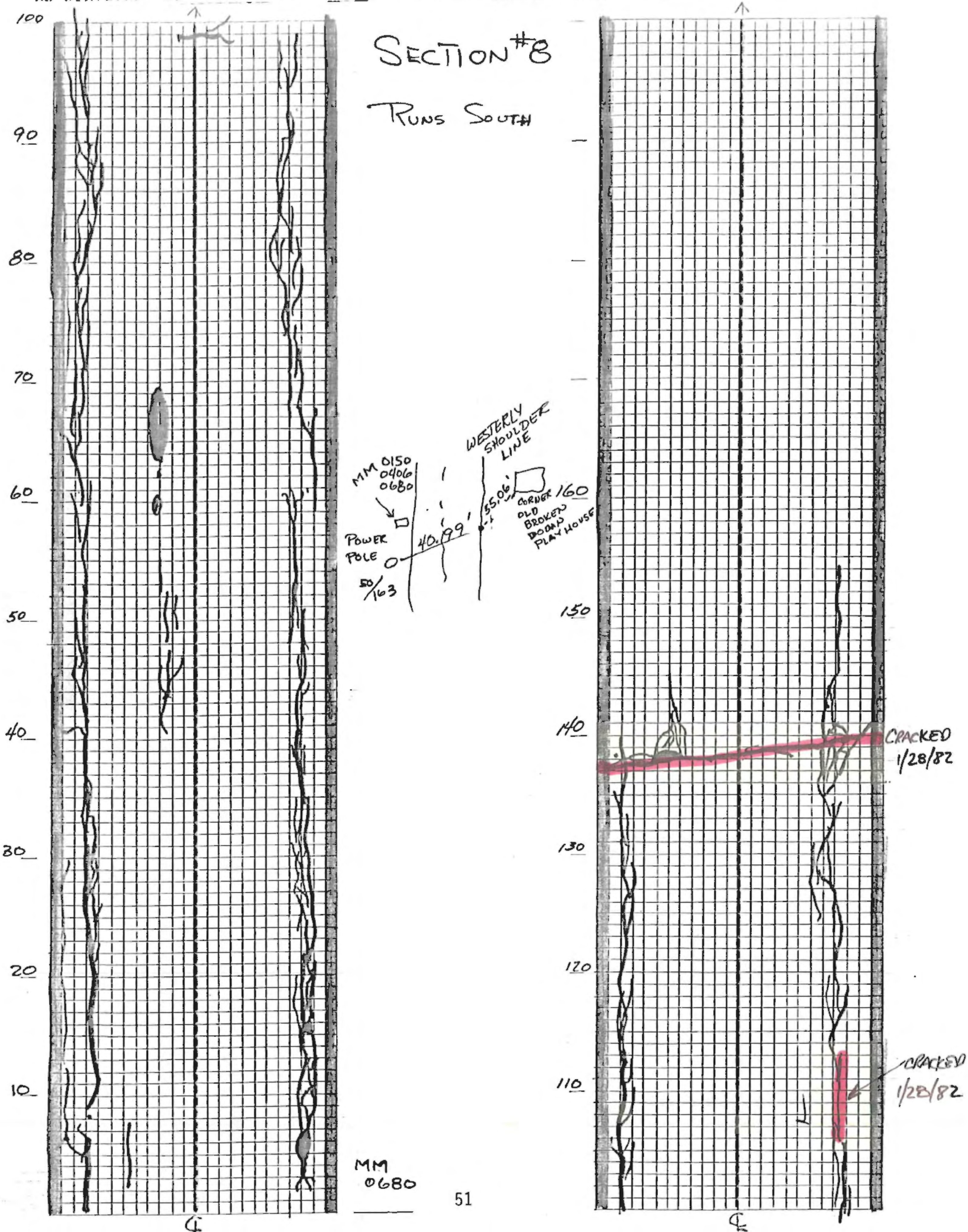
Roadway Width = 25.4'

℄ to ℄ = 23.6'

*Original Reading Before Construction

ORIG. SURVEY BY PC, CM DATE 6/30/81

RE-SURVEYED BY ______ DATE ______ PROJECT ______



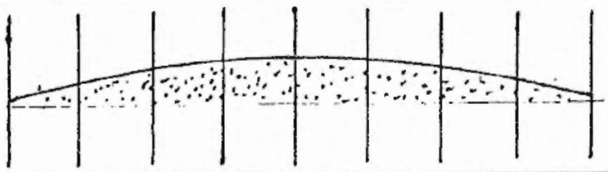
TEST SECTION # 8

S BOUND N BOUND

RUTTING READINGS

PROJECT RTE 15

HOT RECYCLE



DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81 *	0	0	6/16	0	5/16	0	3/16	0	10/16	0
	50'	0	18/16	0	3/16	0	2/16	0	20/16	0
	100'	0	7/16	0	6/16	0	3/16	0	17/16	0
	150'	0	3/16	0	4/16	0	3/16	0	2/16	0
10/6/81	0'	0	2/16	0	1/16	0	2/16	0	0	0
	50'	0	3/16	0	1/16	0	0	0	1/16	0
	100'	0	1/16	0	2/16	0	0	0	1/16	0
	SURVEYED 1/28/82	(1) 22' TRANSVERSE CRACK (1) 7' LONGITUDINAL "								

COMMENT

ROADWAY WIDTH = 25.0'

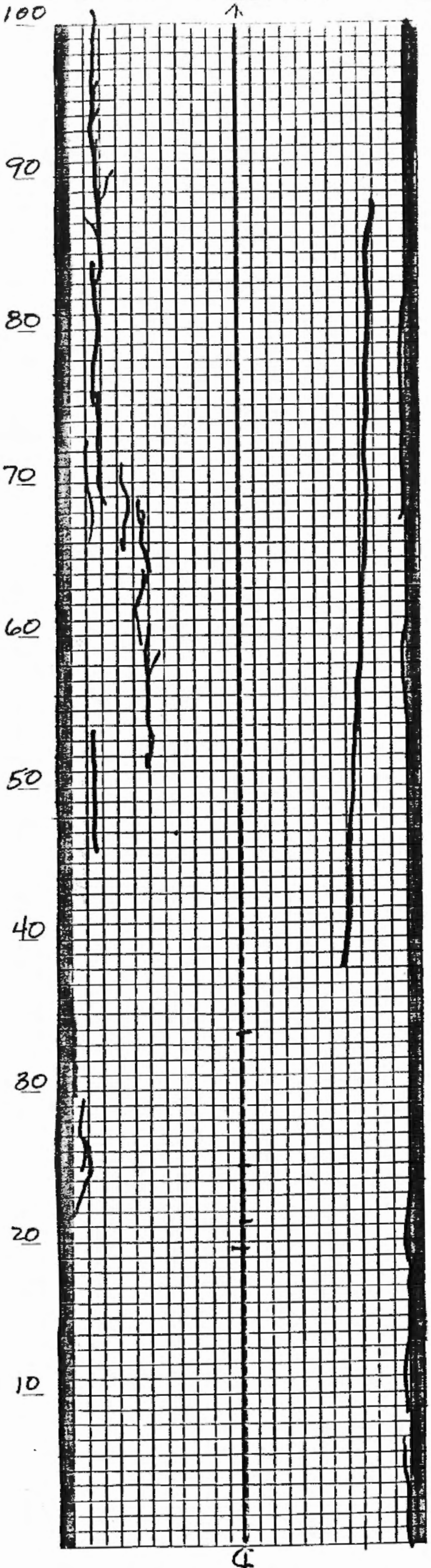
℄ TO ℄ = 23.0'

CRACKS AVG 1/4"

RANGE 1/8" – 3/4"

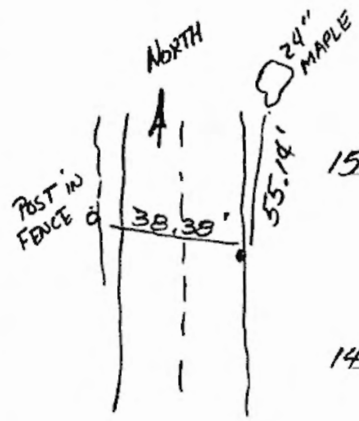
*Original Reading Before Construction

ORIG. SURVEY BY RC & BM DATE 6/30/91 PROJECT ESSEX - JERICHO - UNDERHILL
RE-SURVEYED BY ____ DATE ____



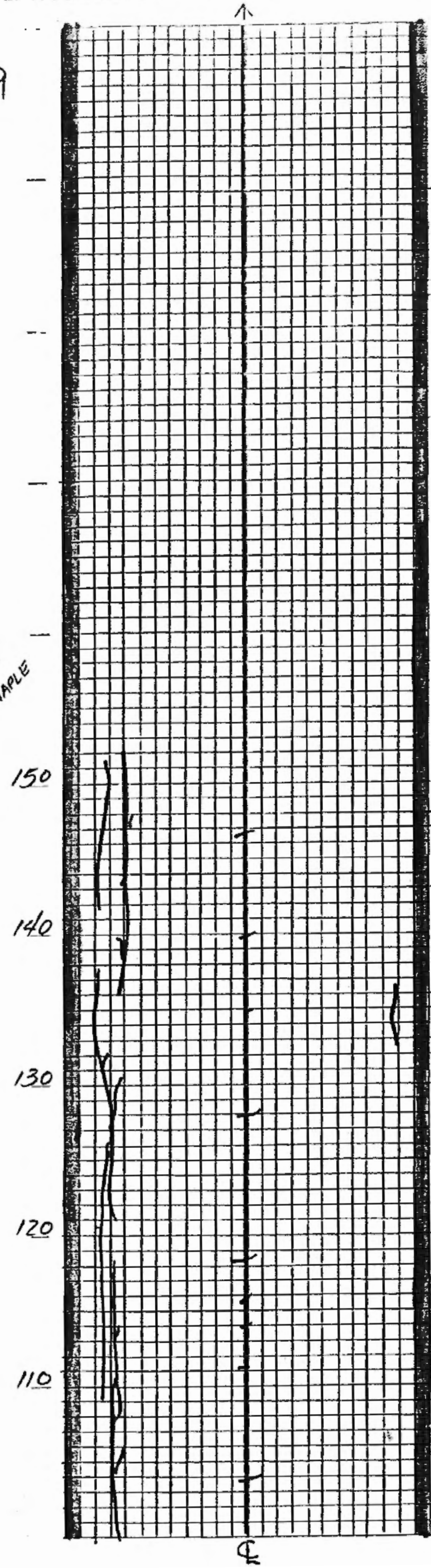
SECTION #9

RUNS NORTH



M 0150
0406
0570

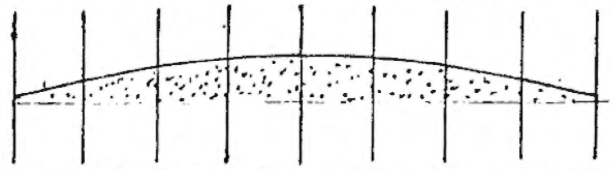
MM
0570



SECTION #9

RUTTING READINGS

PROJECT RTE 15
HOT RECYCLE



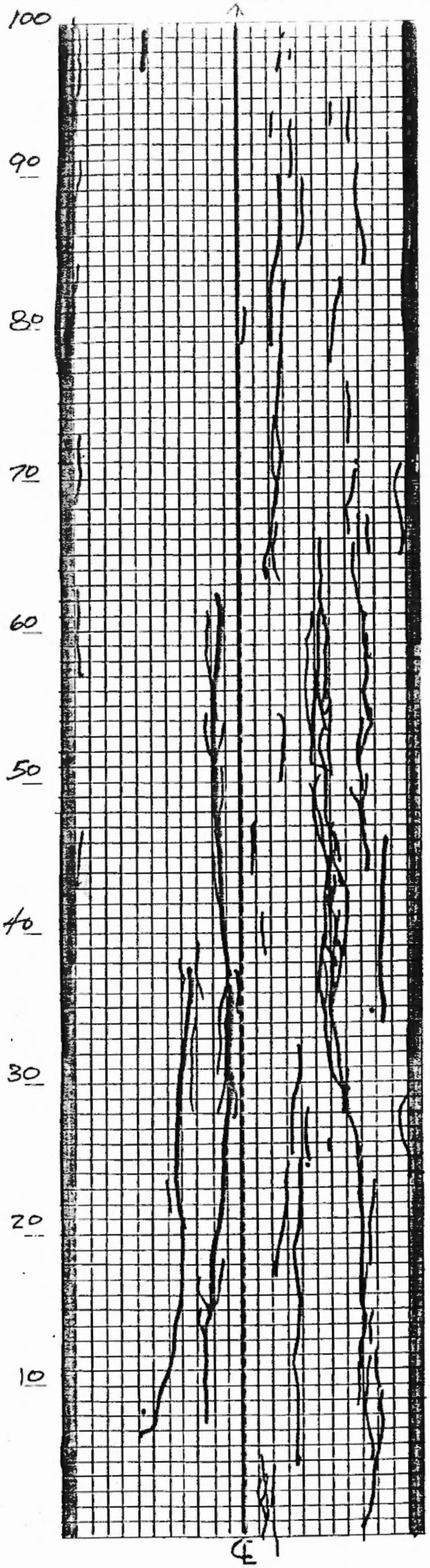
DATE	LOCATION	S BOUND EDGE	S BOUND WHEEL PATH	S BOUND CENTER LANE	S BOUND WHEEL PATH		N BOUND WHEEL PATH	N BOUND CENTER LANE	N BOUND WHEEL PATH	N BOUND EDGE
6/30/81 *	0'	0	8/16	0	10/16	0	5/16	0	4/16	0
	50'	0	8/16	0	7/16	0	5/16	0	4/16	0
	100'	0	3/16	0	7/16	0	3/16	0	5/16	0
	150'	0	7/16	0	6/16	0	7/16	0	4/16	0
10/6/81	0'	0	0	0	0	0	0	0	0	0
	50'	0	1/16	0	1/16	0	2/16	0	0	0
	100'	0	0	0	2/16	0	0	0	1/16	0
	SURVEYED 1/28/82 NO CRACKS									

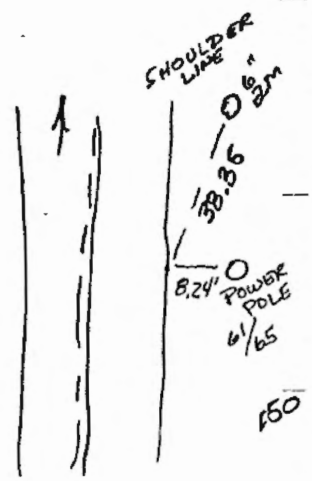
COMMENT
Avg Crack = 1/8"
Range 1/8" - 1/4"
Roadway Width = 25.8'
$ to $ = 233

*Original Reading Before Construction

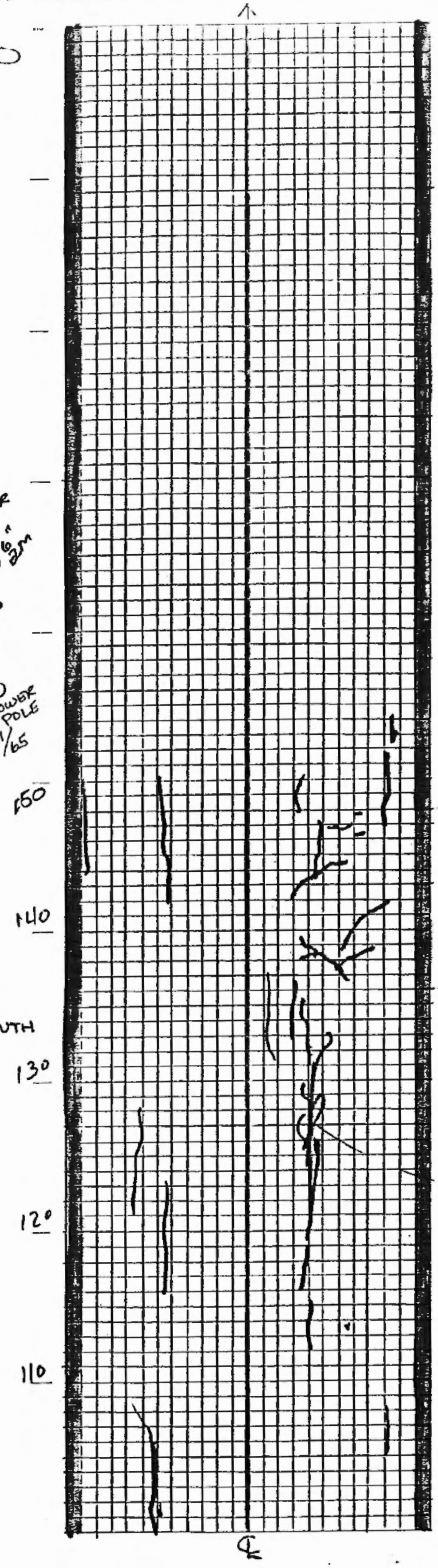
SECTION #10

RUNS SOUTH





APPROX 159' SOUTH OF MM 0150 0406 0400 IN ESSEX



TEST SECTION # 1C

N BOUND S BOUND

RUTTING READINGS

PROJECT Rte 15
HOT RECYCLE

DATE	LOCATION	EDGE	WHEEL PATH	CENTER LANE	WHEEL PATH		WHEEL PATH	CENTER LANE	WHEEL PATH	EDGE
6/30/81*	0'	0	17/16	0	5/16	0	10/16	6/16	19/16	0
	50'	0	8/16	0	3/16	0	10/16	0	17/16	0
	100'	0	8/16	0	7/16	0	8/16	0	2/16	0
	150'	0	11/16	0	2/16	0	7/16	0	6/16	0
	SURVEYED		1/28/82		NO CRACKS					

COMMENT

ROADWAY WIDTH = 26.8
℄ TO ℄ = 23.9
CRACKS AVG 1/4~3/8"
RANGE 1/8"~1 1/2

*Original Reading Before Construction