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EVALUATION OF MATERIALS FOR CONTINGENCY RUNWAYS

LEVEL II

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A literature review was conducted to determine soil and rock types in various European and Middle Eastern countries, and the results are shown in Appendix A of this report. A study was conducted to evaluate the performance of selected materials when used for constructing contingency-type runways for limited operations of F-4C aircraft. A test section consisting of four items was constructed on a prepared lean clay subgrade with a rated CBR of 10 with thickness of base courses over the subgrade determined from present criteria and a sod surface
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over all items. Base course materials used and thicknesses were as follows:

1. Item 1 consisted of 6 inches of well-graded crushed limestone with 3 inches of open-graded crushed limestone on top and approximately 1 inch of sod.

2. Item 2 consisted of 9 inches of sandy gravel stabilized with 5 percent portland cement and approximately 1 inch of sod surface.

3. Item 3 consisted of 11 inches of lean clay stabilized with 12 percent portland cement and 1 inch of sod surface.

4. Item 4 consisted of 15 inches of clayey gravel stabilized with 4 percent lime and 1 inch of sod surface.

The significant findings of this study are as follows:

1. An open-graded crushed stone with a sod surface will rut severely when subjected to the F-4C loading.

2. Cement-stabilized sandy gravel or lean clay will withstand the F-4C loading for more than 200 coverages when designed in accordance with present criteria.

3. Lime-stabilized clayey gravel will withstand more than 200 coverages of the F-4C aircraft loading when designed in accordance with present criteria.

4. A topsoil and sod surface should not exceed 1 inch in thickness or rutting will occur within the topsoil.

5. The topsoil surface would probably slide on the stabilized material when aircraft brakes are applied.

FOREWORD

This report was prepared by the U. S. Army Engineer Waterways Experiment Station (WES) under Project Order No. 77-016, dated 2 November 1976. Job Order No. 21042B25, for Detachment 1 (CEEDO) ADTC, Tyndall AFB, FL.

This report summarizes work done between December 1976 and August 1978. SSgt William F. Mitchell (CEEDO) was the Project Officer. The construction of the test section and evaluation of the performance of materials were performed by Messrs. C. L. Rone and A. L. Sullivan III. Rock types and area of occupancy were performed by Mr. J. H. Shamburger. The report was written by Messrs. Sullivan, Rone, and Shamburger.

This report has been reviewed by the Information Office (IO) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

This Technical Report has been reviewed and is approved for publication.

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SECTION I

INTRODUCTION

BACKGROUND

Modern aircraft dependency on high-quality airfield surfaces has made the airfield runway a vulnerable target for enemy attack. The desirability of attacking the runway has been further enhanced by the widespread construction of hardened aircraft shelters which greatly reduce the vulnerability of aircraft on the ground. An enemy may now attack a runway and effectively neutralize an opponent's airpower by destroying the runway surface and thus stranding the aircraft on the ground. To counter this threat, the need, therefore, exists to have contingency runways that will support a limited number of aircraft operations. Such a concept presents a greater targeting problem thereby increasing the probability of launching the aircraft.

To justify contingency-type facilities, the most economical materials and methods should be used in design and construction, and the facilities should be usable for other purposes except in time of emergency. One method of meeting these requirements is to use materials available near the site and modifying these materials with additives during construction to increase their strength characteristics to support a limited number of aircraft operations. To make the areas usable for other purposes, such as recreation areas, a thin layer of topsoil should be applied to the surface and the area seeded to provide a grass cover.

OBJECTIVE AND SCOPE

The purpose of this investigation was to:

1. Determine soils and rock types as a possible source of construction material and area of occupancy of these materials in various European and Middle Eastern countries using presently available literature. The results of this determination are presented in Appendix A.

2. Evaluate the performance of selected base course materials when subjected to 200 coverages of aircraft traffic with a wheel load of 25,000 pounds and a tire pressure of 250 psi. The evaluation was based on the performance of the material with traffic applied as soon after construction as a grass cover could be established and in a second traffic lane after the materials had gone through a winter season.

3. Determine the feasibility of growing a grass cover on the surface of these base course materials and the effect of traffic on the grass surface.

These objectives were accomplished by:

1. Constructing a test section having a lean clay subgrade with four test items of various base courses.

2. Subjecting the test section to simulated F-4C aircraft traffic loading, using a 25,000-pound single-wheel load on a 30 by 11.5, 24-ply aircraft tire inflated to 250 psi.

3. Observing the behavior of the test section under traffic and during various weather conditions.

4. Monitoring the base courses and subgrade to determine changes in strength.

This report contains a description of the materials used in the test section, construction techniques, tests conducted, and results. The results of the literature review to determine soils and rock types and area of occupancy are given in Appendix A.

SECTION II

MATERIALS, DESIGN, AND CONSTRUCTION

SUBGRADE

Classification data for the subgrade used in the construction of the test section are shown in Figure 1. The subgrade was a lean clay (CL) material with an average liquid limit of 34 and a plasticity index of 12. It was a residual loess deposit natural to the test area. Laboratory water content density relations for the lean clay are shown in Figure 2.

BASE COURSES

Base course materials selected for evaluation in this investigation were determined by selecting materials that were found to be commonly available in countries where contingency-type facilities would most likely be constructed. Classification data for the base courses used are shown in Figure 1. Base course 1 was a dense-graded crushed limestone meeting the requirements as given in Reference 1. Base course 2 was an open-graded crushed limestone. Base course 3 was a sandy gravel, and base course 4 was a clayey gravel with a plasticity index of 16. Laboratory water content density relations for base courses 1, 3, and 4 without stabilizers are shown in Figures 3, 4, and 5. Laboratory water content density relations for the open-graded crushed limestone were not determined.

LOCATION OF THE TEST SECTION

The test section was located in an open area on the Waterways Experiment Station (WES) reservation on a lean clay (loess-type soil) deposit.

DESIGN

A plan, profile, and typical section of the test section are shown in Figure 6. The test section was 35 feet wide and 200 feet long and consisted of four test items, each 35 feet wide and 50 feet long. Each item was constructed over a lean clay subgrade. Item 1 consisted of a 6-inch dense-graded base course of crushed limestone with 3 inches of an open-graded crushed limestone placed above this base. The base course for item 2 was 9 inches of sandy gravel stabilized with 5 percent portland cement. Item 3 base course consisted of 11 inches of lean clay stabilized with 12 percent portland cement and 15 inches of clayey gravel stabilized with 4 percent hydrated lime was used for the base course in item 4. Approximately 1 inch of topsoil was spread evenly over each item, then seeded with grass to provide a grassy surface. Lean clay shoulders were used to confine the base courses in order to facilitate their compaction.

The thickness of base courses above the prepared subgrade was determined in accordance with criteria developed and presented in Reference 2. Laboratory water density relationships and past experience with the lean clay subgrade material indicated that a rated CBR of 10 could be expected in the prepared subgrade when the water content has stabilized after construction. Therefore, thickness of base courses was determined using a subgrade CBR of 10 and applying factors given in Reference 3 for obtaining the thicknesses of each stabilized base course to support 200 passes of the F-4C aircraft with a wheel load of 25,000 pounds and a tire pressure of 250 psi.

CONSTRUCTION

An area 260 feet long and 35 feet wide was divided into four 50-foot-long and 35-foot-wide test items with a 30-foot-long by 35-foot-wide maneuver area at each end.

SUBGRADE

The natural soil in this area was lean clay, having an average water content of approximately 23.0 percent. About 400 cubic yards of this material was hauled to a special processing site where it was dried to an average water content of 17.5 percent for use as the top 6 inches of compacted subgrade. The bottom of the excavation was processed in place with a pulvimixer (Figure 7) to an average water content of 18.0 percent. Compaction was applied to this layer with 16 passes of a double-drum sheepsfoot roller (Figure 8), each drum weighing 10,000 pounds, resulting in an average dry density of 101.0 lb/cu ft and a water content of 17.5 percent.

Lean clay material was then hauled by dump truck from the processing site and end dumped onto the section. The material was spread with a D-4 tractor to a uniform loose depth of 8 inches to allow for compaction to a 6-inch compacted thickness. The section was then compacted with 16 passes of the sheepsfoot roller. The subgrade was then rolled with eight coverages of a self-propelled rubber-tired roller weighing 47,000 pounds with the seven tires inflated to 90 psi, resulting in a average dry density of 102.5 lb/cu ft and a water content of 17.0 percent.

A motor grader was used to shape the subgrade (Figure 9) to a 6-inch uniformly processed layer, having a longitudinal slope of 0.5 percent and a transverse slope of approximately 1 percent from the center line of the section to each shoulder. Steps of 2 and 6 inches were cut with the motor grader in items 3 and 4, respectively, to allow for the thicker base courses in these items, while retaining a uniform grade along the test section. The shoulders of the test section were sloped into drainage ditches on each side of the section.

ITEM 1

Dense-graded crushed limestone was hauled by dump truck and end dumped on the item and spread with a D-4 tractor to a uniform thickness of 6 inches. The base was then rolled with 30 coverages of a 47,000-pound self-propelled rubber-tired roller having seven tires, each inflated to 90 psi.

A 3-inch thickness of open-graded crushed limestone was spread with a motor grader (Figure 10) over the dense-graded limestone. The open-graded layer of crushed limestone was then rolled with four passes of a steel-wheel roller (Figure 11). The as-constructed CBR, density, and water content data for item 1 are shown in Table 1.

ITEM 2

Item 2 was constructed in two compacted lifts of approximately 5 inches each. The sandy gravel material for each lift was spread on a processing strip to a thickness of about 10 inches. Five percent by weight of portland cement was distributed by hand over the area prior to spreading. Figure 12 shows the distribution of bags of cement over the material. The cement was then mixed with the sandy gravel with a pulvimixer as shown in Figure 13. The material was further mixed as it was being piled and loaded into the dump trucks. The first 5-inch lift was then dumped onto the test section and spread with a D-4 tractor (Figure 14). This lift was compacted with 16 coverages of a 47,000-pound self-propelled rubber-tired roller (Figure 15). The second lift was 4 inches thick and prepared in the same manner as the first, with the exception that a motor grader was used to grade the sandy gravel to a more uniform thickness prior to compaction (Figure 16). The surface of the item was finished with four passes of a steel-wheel roller to remove surface ruts caused by the rubber-tired roller. After compaction, the item was covered for 7 days with a polyethylene membrane for curing. The results of CBR, water content, and density determinations taken 9 days after construction are shown in Table 1. During construction, samples of the material were taken, and laboratory specimens were compacted using the CE-55 compaction effort. Laboratory CBR tests were performed on soaked and unsoaked specimens at various ages, and the results are shown in Table 3.

ITEM 3

This item was constructed in the same manner as Item 2, with the exception that lean clay stabilized with 12 percent portland cement by weight, was used and placed in two compacted lifts approximately 6 inches thick. A motor grader was used after compaction to remove surface ruts caused by the rubber-tired roller during compaction. The item was cured for 7 days with a polyethylene cover. The results of in-place CBR, density, and water content determinations taken 8 days after construction are shown in Table 1. During construction, samples of the material were taken, and laboratory specimens compacted using the CE-12 compaction effort. The results of soaked and unsoaked CBR tests on these specimens are shown in Table 3.

ITEM 4

The clayey gravel base course for this item was also prepared in two lifts, using the same procedures for mixing 4 percent, by weight, of hydrated lime as a stabilizer (Figure 17). The lifts were approximately 8 inches thick, and eight passes with a sheepsfoot roller (Figure 18) were applied to each lift before compacting with the rubber-tired roller to break down the bridging of the material under the tracks of the D-4 tractor used for spreading. Curing was accomplished by using a polyethylene membrane cover over the item for 7 days. In-place CBR, density, and water content determinations taken 2 days after construction are shown in Table 1. Samples of the material were taken during construction, and laboratory specimens were compacted at the CE-55 compaction effort. Soaked and unsoaked CBR's were determined on these specimens, and the results are shown in Table 3.

TOPSOIL

When construction of the base courses for all items was completed, topsoil was stripped from a nearby area and dumped by end loader upon the surface of the test section. It was then spread approximately 1 to 1-1/2 inches thick by hand (Figure 19). The entire section was rolled with two passes of a steel-wheel roller (Figure 20) to tighten the soil to guard against erosion. The topsoil surface was fertilized, seeded with Bermuda, and watered regularly to establish a grass cover. Watering of the topsoil was commenced immediately after construction, and the entire section was completely saturated three times weekly until a few days prior to traffic on lane 1. This constituted an extraordinary amount of simulated rainfall which would create a very severe climatic condition for the materials being evaluated. An overall view of the grass surface prior to traffic is shown in Figure 21.

TEST VEHICLE

A specially designed test vehicle, having a single-wheel load of 25,000 pounds, was used in the traffic tests (Figure 22). The test cart, equipped with an outrigger to prevent overturning, was powered by the front half of a four-wheel-drive truck. The load cart was equipped with a 30 by 11.5, 24-ply F-4C tire inflated to 250 psi. At this loading and tire pressure, the tire had a contact area of approximately 100 square inches.

SECTION III

TESTS AND RESULTS

TRAFFIC LANES

Traffic lanes were as shown in Figure 6. Lane 1 was trafficked approximately 4 months after construction when the grass cover and root system were established. An overall view of lane 1 prior to traffic is shown in Figure 23. Traffic was applied to lane 2 after the test section went through a winter season.

TRAFFIC DISTRIBUTION

Traffic was distributed in a lane 120 inches wide to simulate the distribution normally encountered in actual aircraft landings and takeoffs. Traffic was applied in the pattern shown in Figure 24 using a rope guideline and moving the guideline across the traffic lane at 10-inch intervals (one tire width) as traffic was being applied. To apply the traffic over the 120-inch-wide traffic lane in the pattern depicted, the load cart first traveled along the guideline at position 1 (north side of traffic lane) and then traveled back along the same line, which resulted in two passes in this wheel path. The guideline and load cart were shifted laterally to positions 2-12 in succession for a pass in each direction. The guideline and load cart were shifted to position 11, and a pass applied in both directions to positions 11-2. This procedure was followed until a total of eight passes had been applied to positions 2-11, and two additional passes were applied to positions 4-9 for a total of 10 passes on positions 4-9. This procedure required 96 passes to complete one distribution pattern as shown in Figure 24. Therefore, for computing passes-to-coverage ratio, 96 passes would be necessary in the test lane to produce 10 coverages at the peak of the distribution curve. The passes-to-coverage ratio becomes 96/10 = 9.6. The passes-to-coverage ratio for the F-4C on a runway is 17.0; therefore, the number of coverages of traffic applied to the test lanes multiplied by 17.0 gives the number of operations on an actual runway.

DRAWBAR PULL

Immediately prior to traffic in each lane, rolling-wheel drawbar pulls were made along the center line of the traffic lane. The load cart was towed by a military 6 x 6, 5-ton truck, and the force measured by a pressure cell connected to the towing cable. Figure 25 shows the arrangement and recording of load readings. The load cart was stopped in the center of each item for 1 minute. Table 2 shows the force required to start the cart and the average force required to keep the cart rolling along the section. Drawbar pulls were also performed on items 2, 3, and 4 after the grass sod was removed. These pulls were made following the same procedure as those prior to traffic, and the forces are shown in Table 2.

SOILS TESTS AND MISCELLANEOUS OBSERVATIONS

In-place CBR, dry density, and water content tests were conducted on each item of the subgrade and base course during construction and after traffic.

Results of these tests are presented in Table 1. A minimum of three determinations was made at each location indicated, and the values in Table 1 are averages of these values.

Level readings were taken in each item on the surfaces of the subgrade, base course, and grass during construction and at various intervals of traffic. These data are shown in typical cross sections in Figure 26.

A rolling-wheel drawbar pull was determined along the center line of each test lane prior to traffic and at 100 coverages in items 2, 3, and 4 after the grass surface had been removed, and results are shown in Table 2.

Visual observations of construction and behavior under traffic were recorded and supplemented with photographs.

FAILURE CRITERIA

In judging the failure of the test items, either or both of two conditions were considered failures:

1. Single ruts including upheaval at the side of the tire of 3 inches or more.

2. Deformation across the traffic lane combined with upheaval at the edge of traffic lane of 3 inches or more.

BEHAVIOR UNDER TRAFFIC - LANE 1

On 25 August 1977, traffic was initiated on lane 1 of the test section. Figure 27 shows item 1 prior to traffic. Typical cross sections taken at zero coverages and failure are shown in Figure 26.

After two passes, item 1 became impassable, and traffic was terminated. A rut depth of approximately 6 inches (Figure 28) including upheaval at the sides of the tire was measured in the wheel path at the termination of traffic in item 1.

In-place CBR, density, and water content determinations were made in the traffic lane after traffic, and the results are shown in Table 1.

ITEMS 2, 3, AND 4

An overall view of items 2, 3, and 4 prior to traffic are shown in Figures 29, 30, and 31, respectively. Typical cross sections taken at 0, 60, and 200 coverages are shown in Figure 26.

The Bermuda grass sod surface began wearing noticeably at 30 coverages, and most of the grass was worn off by 60 coverages with very little rutting of the topsoil (Figures 32, 33, and 34) except in isolated areas where the topsoil exceeded 1 inch.

At 94 coverages, a 1-inch rainfall caused the topsoil surface to be slick. In order to continue traffic, the topsoil was removed from the traffic lane. Traffic was resumed; and after application of 200 coverages as required by the sponsor, traffic was terminated on lane 1.

Items 2, 3, and 4 showed no noticeable deformation. Slight surface abrasion and dusting caused by the drive wheels of the load cart, as shown in Figures 35, 36, and 37, was noted in all three items, and a minor amount of ravelling was noted in item 2. Figures 38, 39, and 40 show the overall conditions of items 2, 3, and 4, respectively, after 200 coverages.

In-place CBR, density, and water content determinations were made in each item after 200 coverages, and the results are shown in Table 1.

BEHAVIOR UNDER TRAFFIC - LANE 2

Traffic was initiated on 21 March 1978 on lane 2 after the section had undergone a winter season. A general view of lane prior to traffic is shown in Figure 41.

A rolling-wheel drawbar pull was performed down the center line of lane 2 prior to traffic, and item 2 was badly rutted during the pull due to the 4-inch thickness of topsoil in this item (Figure 42). The 4-inch thickness of topsoil in this area was caused by dumping the material in the area; and when it was spread, it was inadvertently left above grade. The topsoil was removed from item 2 prior to testing traffic. A rolling-wheel drawbar pull was also performed on lane 2 at 84 coverages after the topsoil was removed from items 3 and 4.

ITEM 1

A general view of the condition of item 1 prior to traffic is shown in Figure 43. The performance of this item was typical of its performance in lane 1. After two passes with the test cart, item 1 became impassable. The load wheel made a 5-1/2-inch rut including upheaval at the sides of the tire, and the drive wheels were unable to get traction in the loose topsoil and coarse stone surface; therefore, traffic was terminated. A close-up of item 1 at failure is shown in Figure 44.

ITEMS 2, 3, AND 4

General views of items 2, 3, and 4 prior to traffic are shown in Figures 45, 46, and 47, respectively. Items 2, 3, and 4 performed well throughout the traffic test and were basically undamaged after traffic was terminated at 200 coverages. Topsoil performance in lane 2 was similar to that in lane 1. The grassy surface was worn off after approximately 50 coverages, with very slight rutting in the topsoil. A light rainfall after 84 coverages caused the topsoil surface to become slick, and the remaining topsoil was stripped from the traffic lane to allow test traffic to continue.

The remainder of the test traffic was performed on the surface of the stabilized materials with little effect on the test materials other than a slight ravelling and dusting of the surfaces. Again, as in lane 1, the ravelling was more pronounced in item 2.

Deformation of the surface was practically nonexistent in items 2, 3, and 4 after 200 coverages as shown in the closeup photographs in Figures 48, 49, and 50. A general view of the condition of items 2, 3, and 4 after 200 coverages is shown in Figures 51, 52, and 53.

SECTION IV

CONCLUSIONS

Based on data obtained from this study, the following conclusions are believed warranted:

1. Facilities can be constructed using stabilized sandy gravel, clayey gravel, or lean clay that will withstand 200 coverages of the F-4C aircraft if constructed in accordance with presently available design criteria.

2. An open-graded crushed stone with topsoil on the surface and a grass sod is not stable when subjected to the F-4C wheel load.

3. A sod surface can be grown on a stabilized material if adequate moisture is provided.

4. The sod surface should not exceed a 1-inch thickness in order to prevent rutting in the sod layer when subjected to the F-4C loading.

5. Exposure to the elements through a winter season did not effect the stability of the stabilized layers when subjected to the F-4C loading.

6. This test indicated that the topsoil and sod surface would possibly cause a problem if braking occurred on the sodded area.

7. Removal of the sod would not detrimentally effect the load-carrying capacity of the stabilized layers.

REFERENCES

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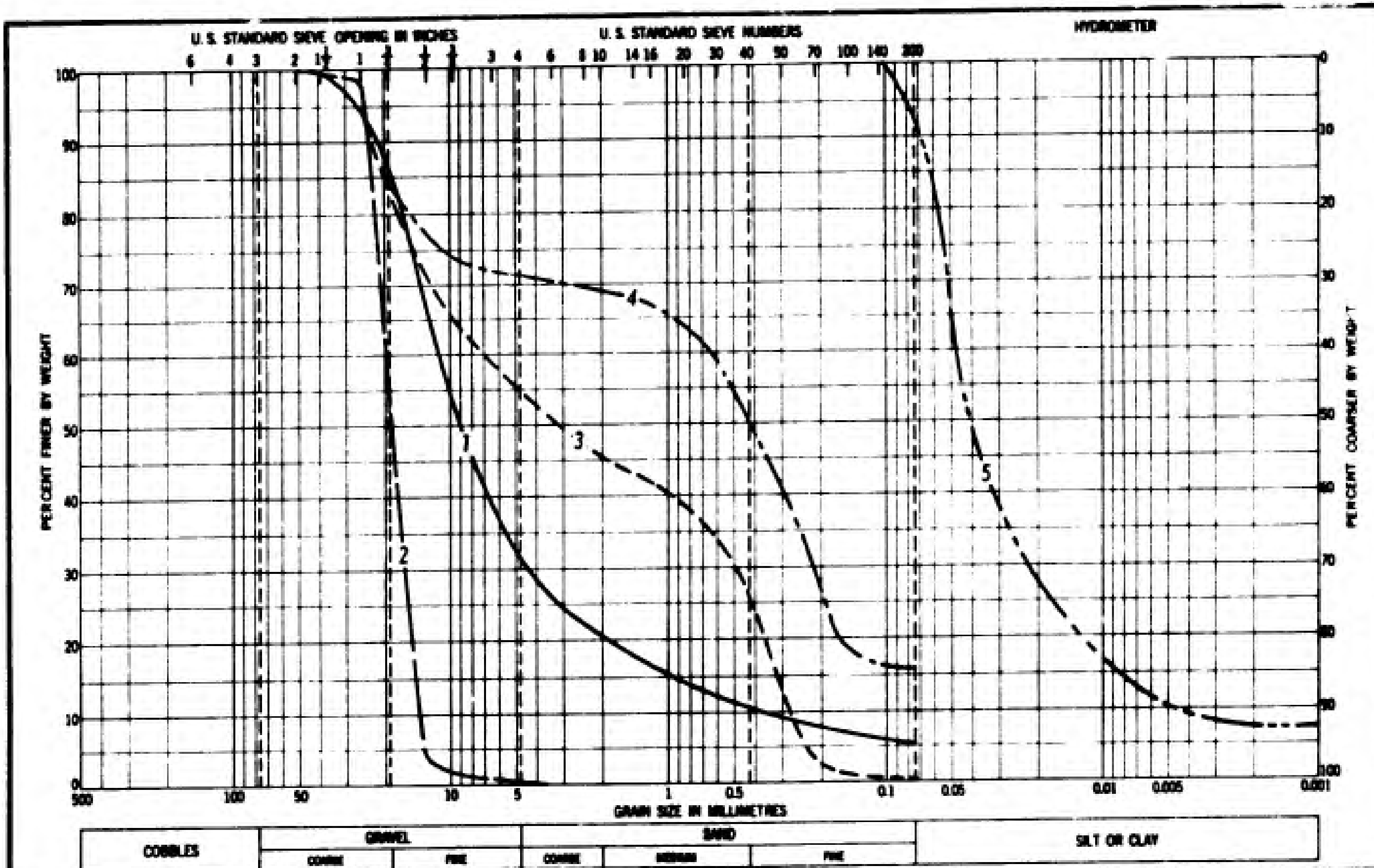
3. Brabston, W. N. and Hammitt, G. M., "Soil Stabilization for Roads and Airfields in the Theater of Operations," Miscellnaeous Paper S-74-23, Sep 1974, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1		CRUSHED LIMESTONE (GP-GM)				NP
2		CRUSHED LIMESTONE (GP)				NP
3		SANDY GRAVEL (GP)				NP
4		CLAYEY, GRAVELLY SAND (SC)		29	13	16
5		LEAN CLAY		34	22	12

GRADATION CURVES

Project

Area

Boring No.

Date

Figure 1. Classification Data

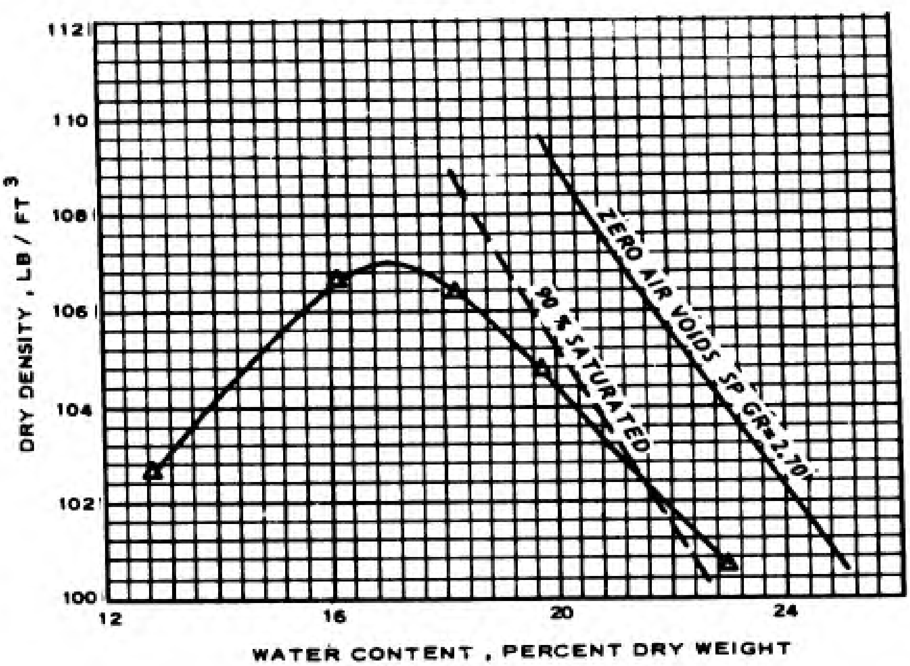


Figure 2. Water Content - Density Relations
(Lean Clay, CE-12 Compactive Effort)

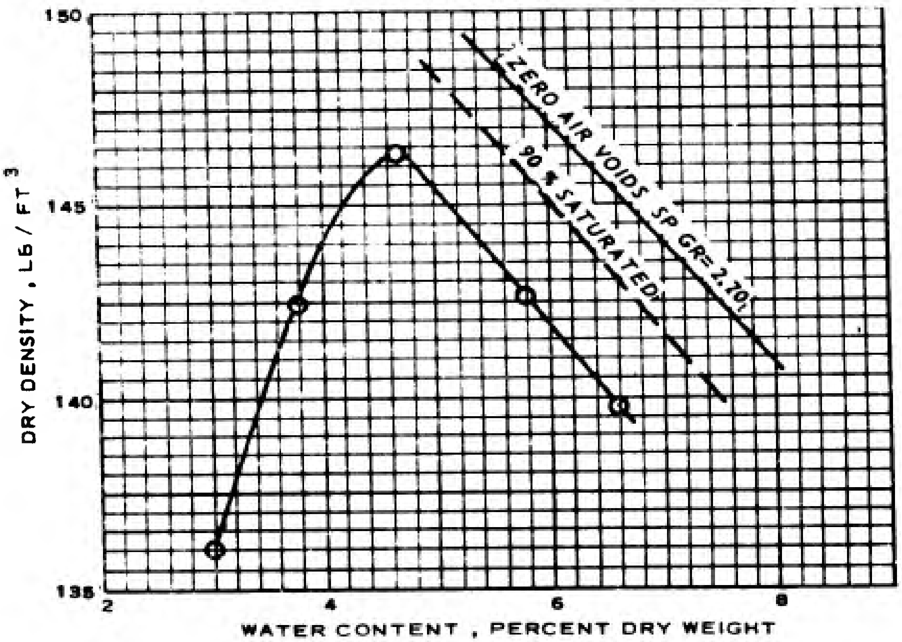


Figure 3. Water Content - Density Relations
(Crushed Limestone, CE-55 Compactive Effort)

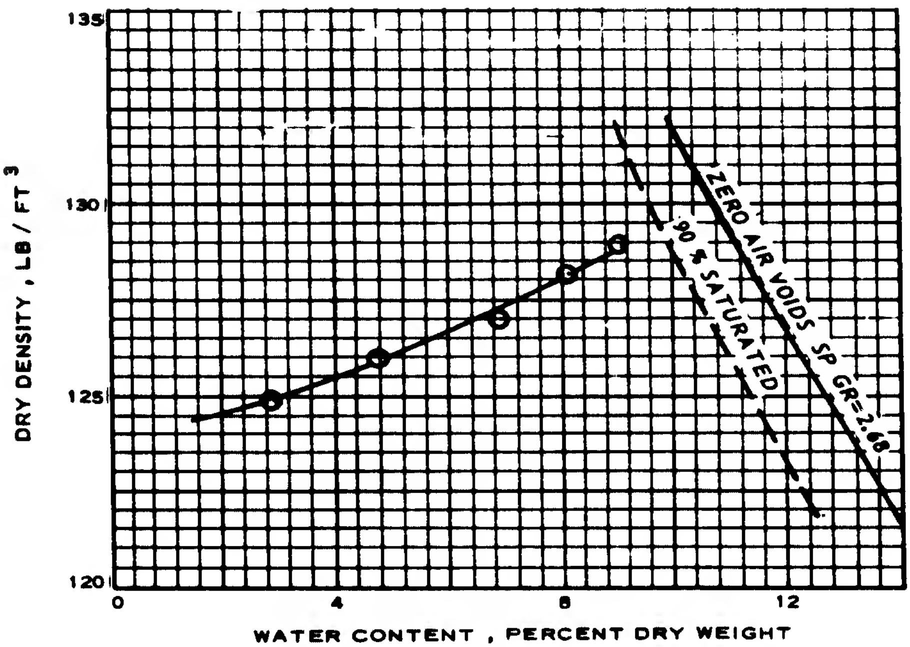


Figure 4. Water Content - Density Relations
(Sandy Gravel, CE-55 Compactive Effort)

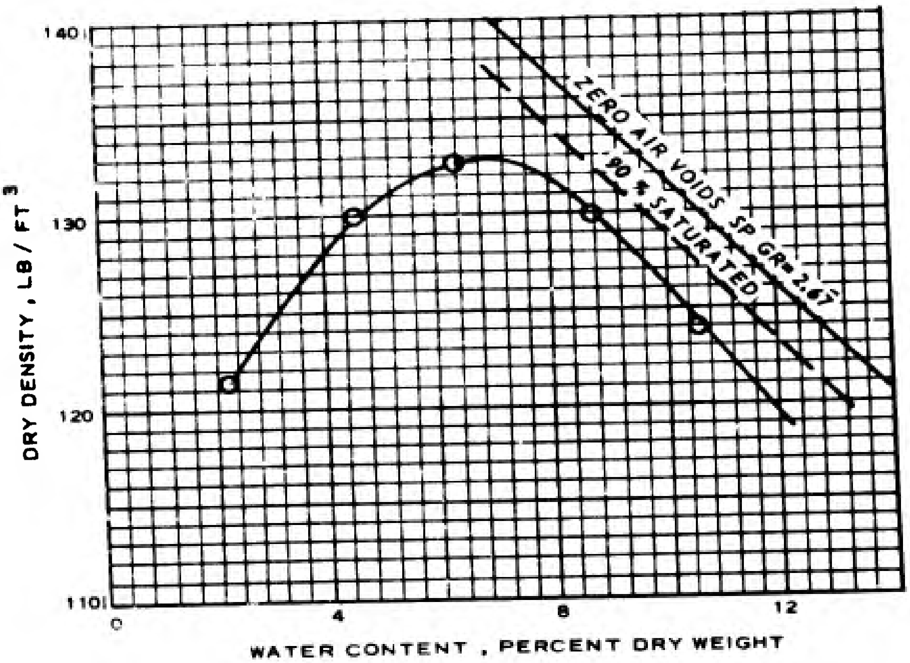


Figure 5. Water Content - Density Relations
(Clayey Gravel, CE-55 Compactive Effort)

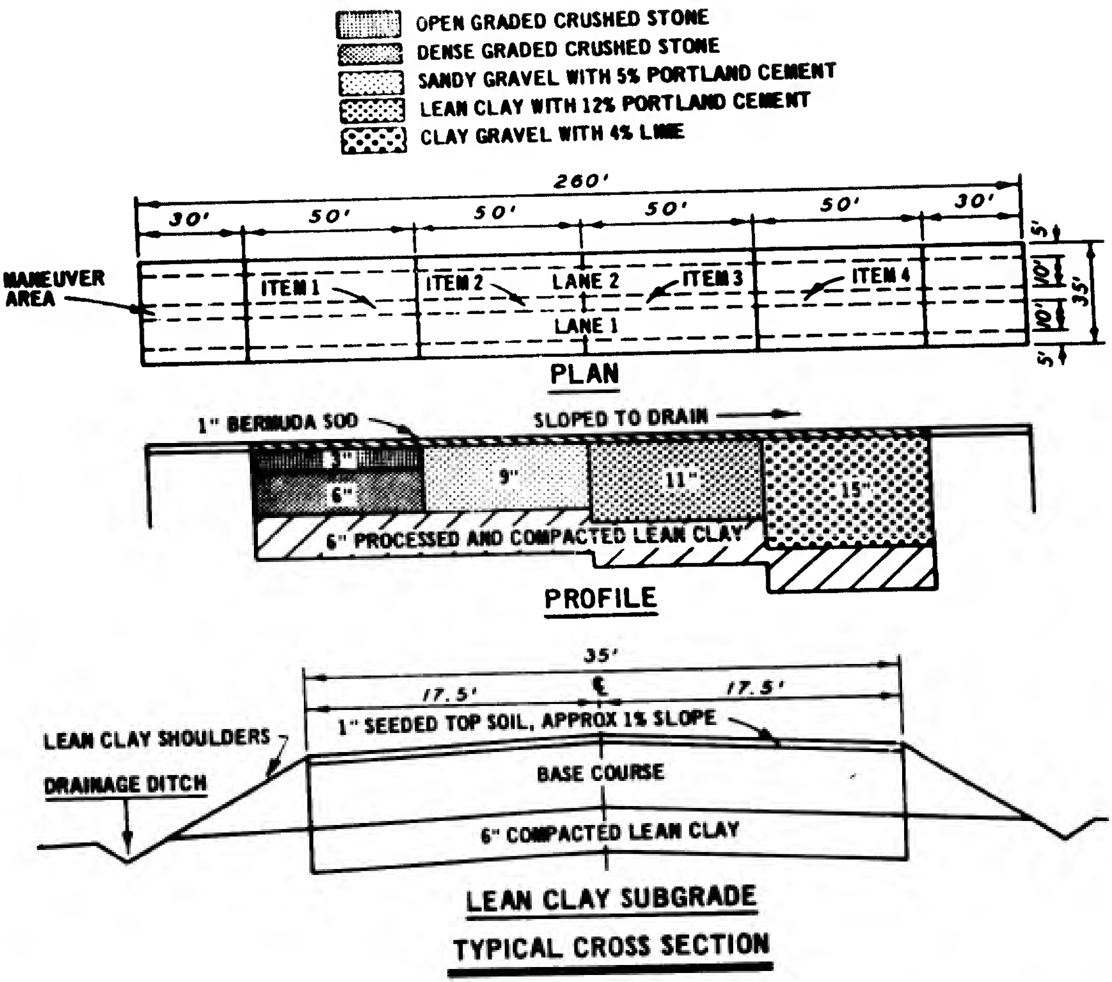


Figure 6. Plan, Profile and Typical Cross-Section of Test Section

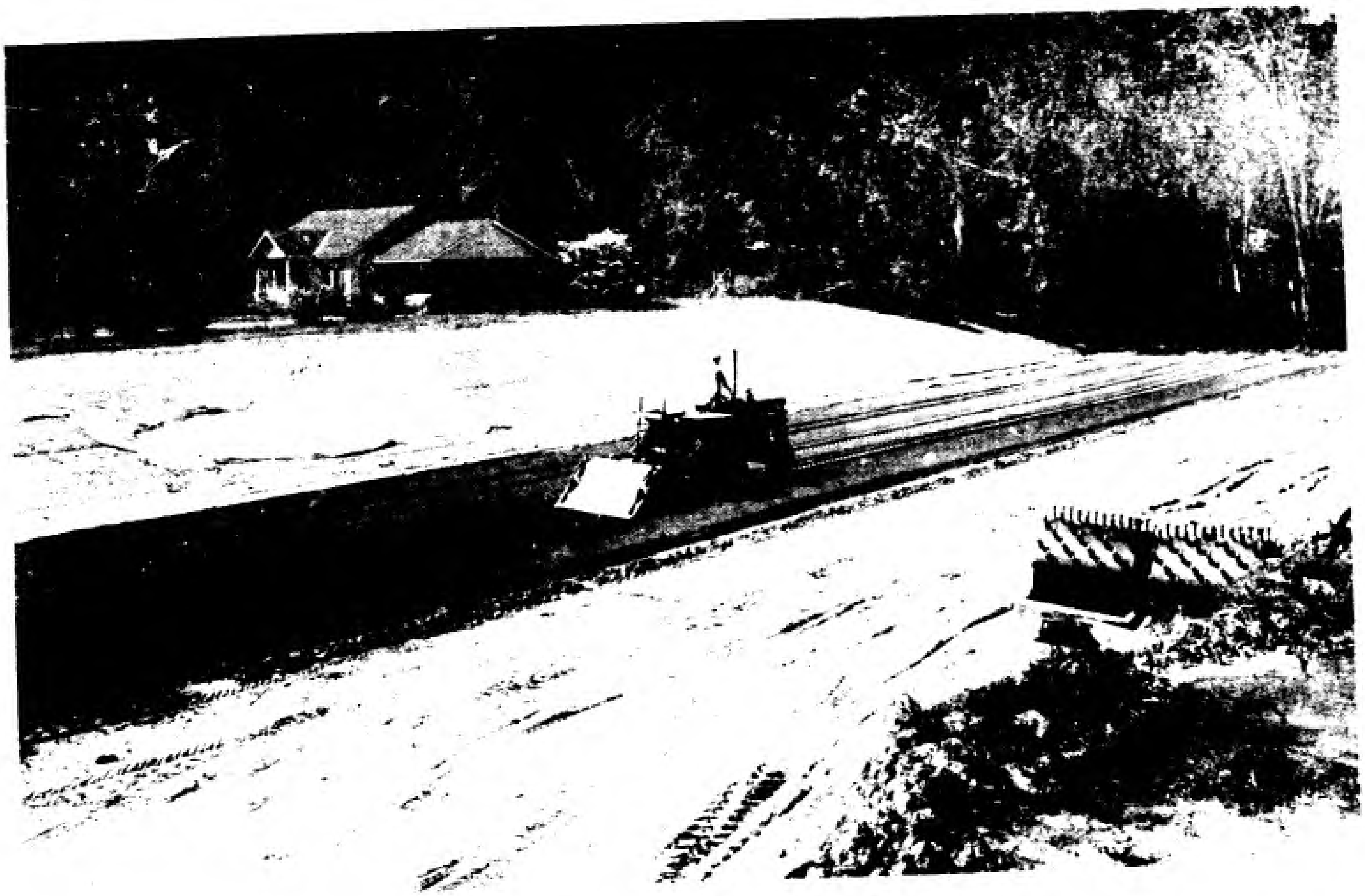


Figure 7. Processing Lean Clay Subgrade with Pulvermixer

Figure 8. Compacting Lean Clay Subgrade with Sheepsfoot Roller

Figure 9. Shaping and Grading Lean Clay Subgrade with Motor Grader

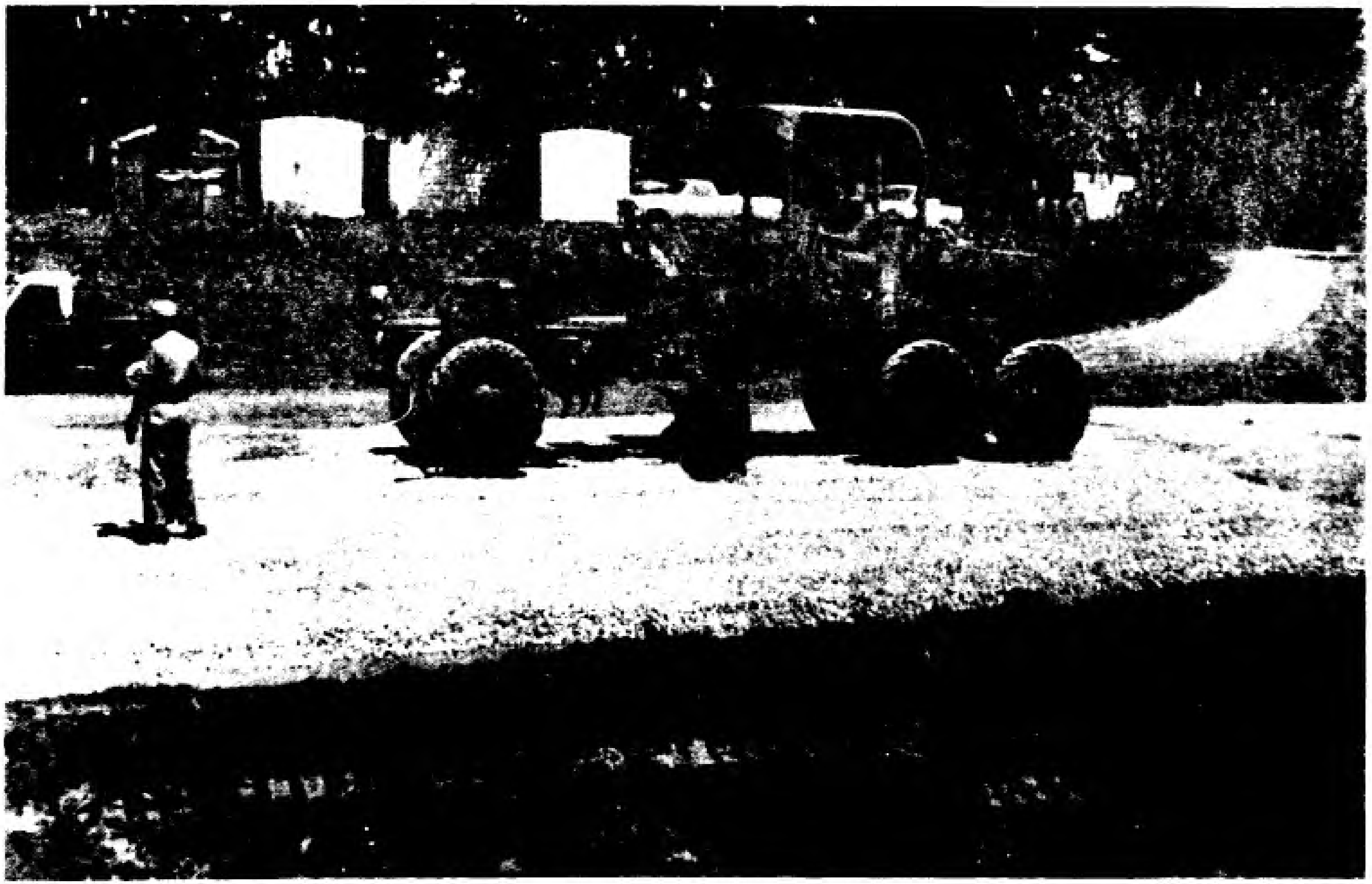
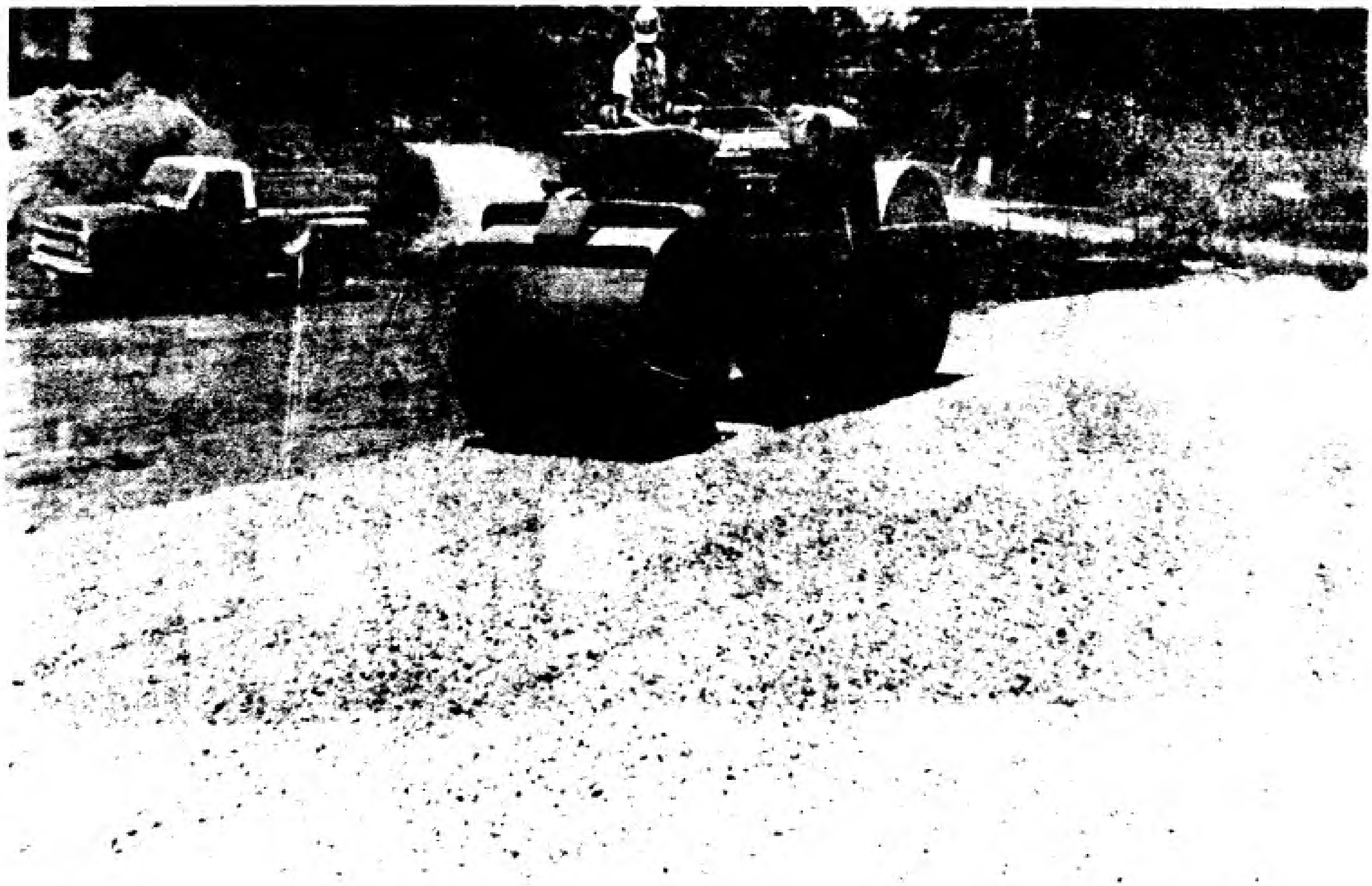


Figure 10. Spreading Coarse Aggregate with Motor Grader



[illegible] 11. Compacting Open-Grade[illegible]

Figure 12. Portland Cement Distributed Over Sandy Gravel

Figure 13. Mixing Cement and Sandy Gravel with Pulvermixer

Figure 14. Dumping and Spreading Stabilized Sandy Gravel - Item [illegible]

Figure 15. Compacting Sandy Gravel with Self-Propelled Rubber-Tired Roller - Item 2

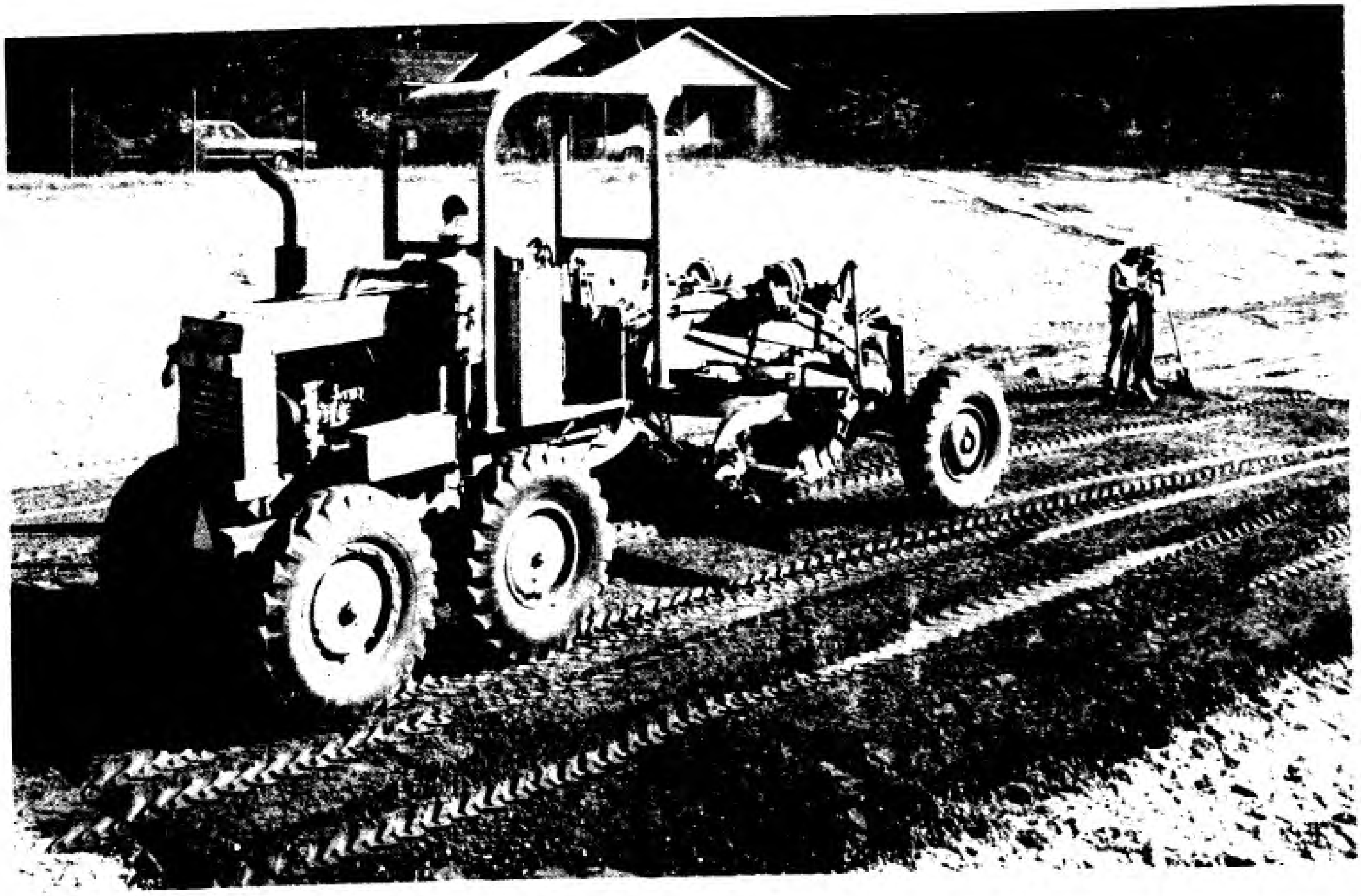


Figure 16. Shaping Sandy Gravel - Item 2

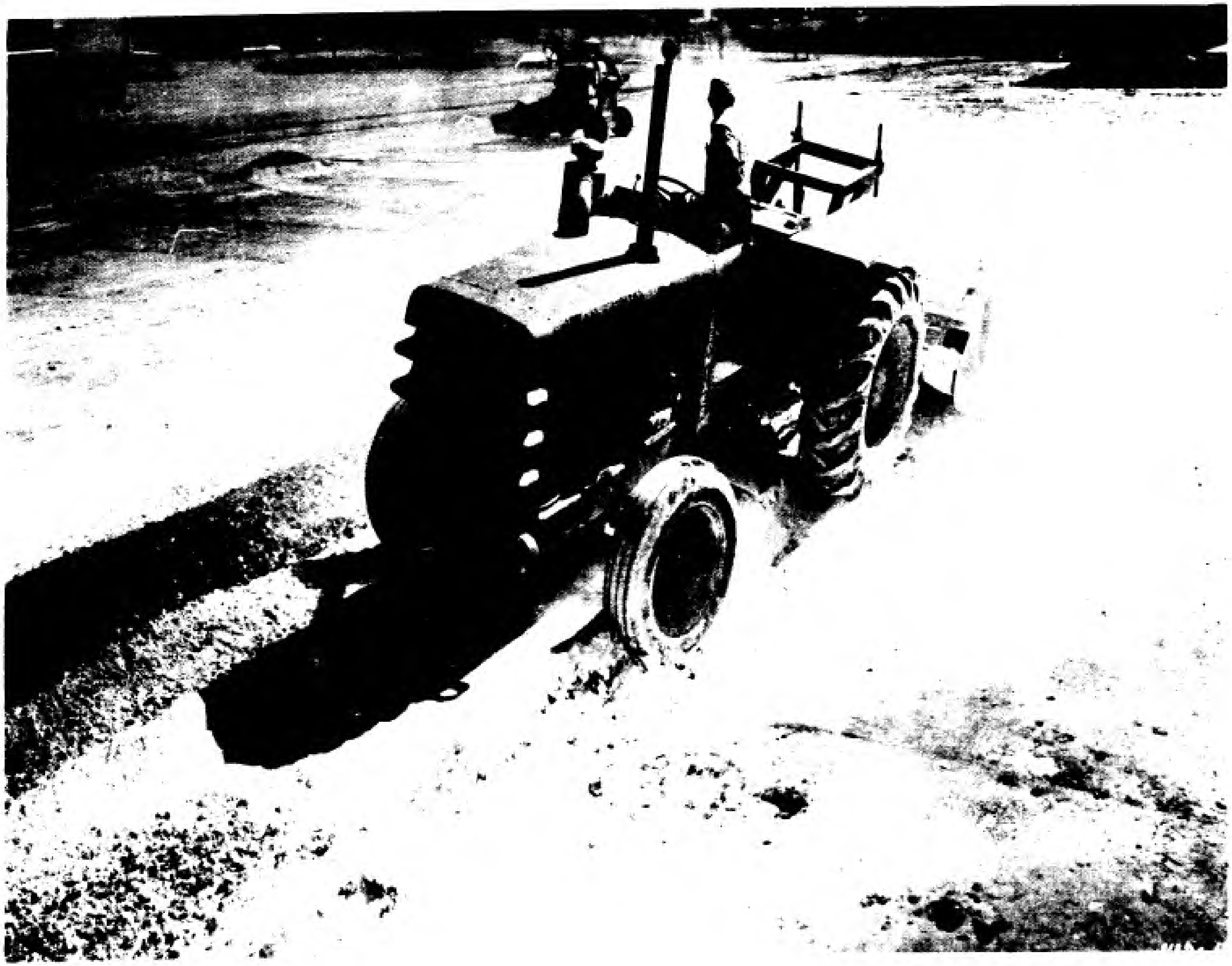


Figure 17. Mixing Lime with Clayey Gravel

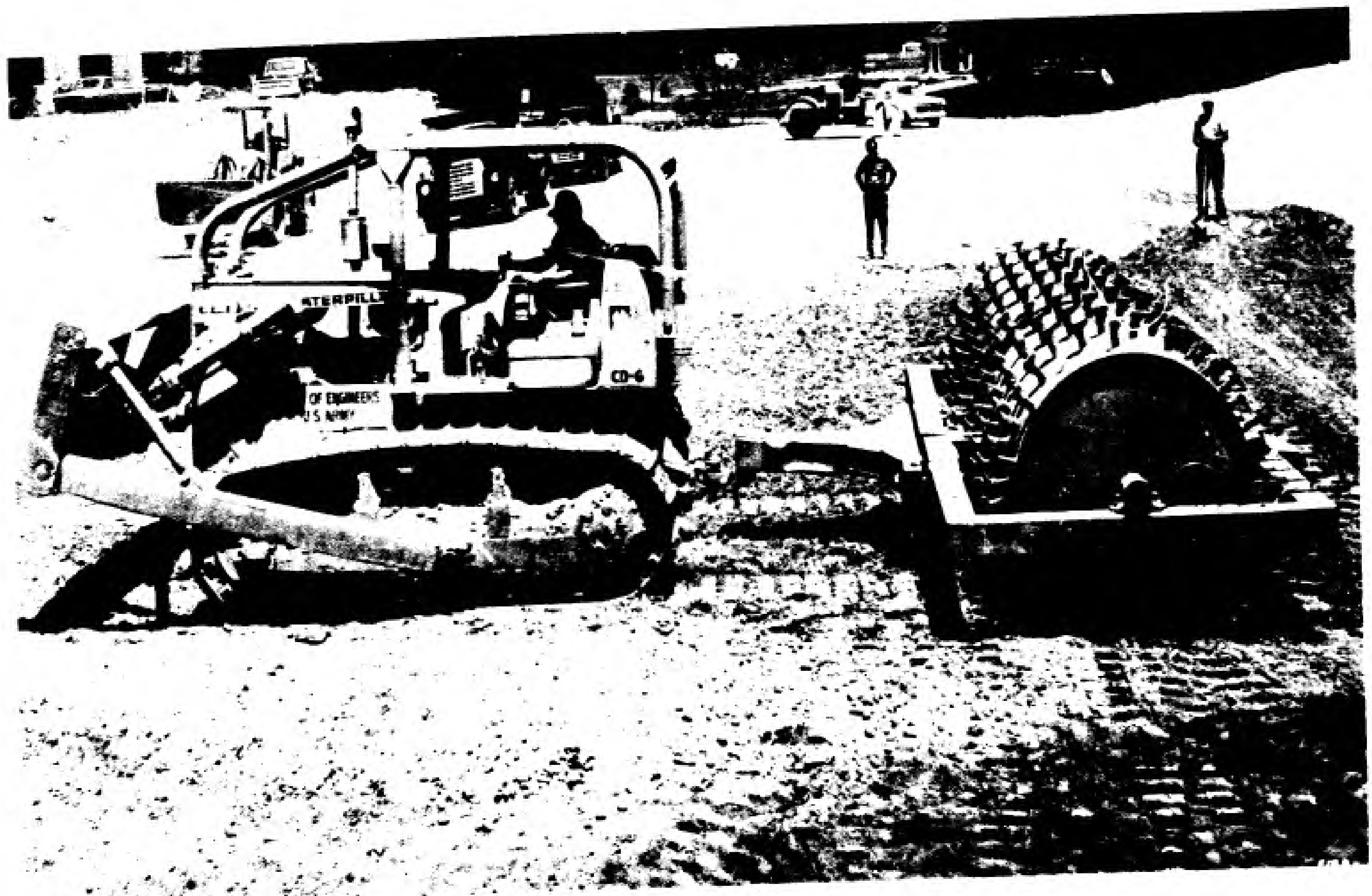


Figure 18. Breaking Down Bridging in Item 4 with Sheepsfoot Roller

Figure 19. Spreading Topsoil

Figure 20. Rolling Topsoil with Steel-Wheel Roller

Figure 21. General View of Sod Surface Prior to Traffic

Figure 22. Test Vehicle

Figure 23. General View of Lane 1 Prior to Traffic

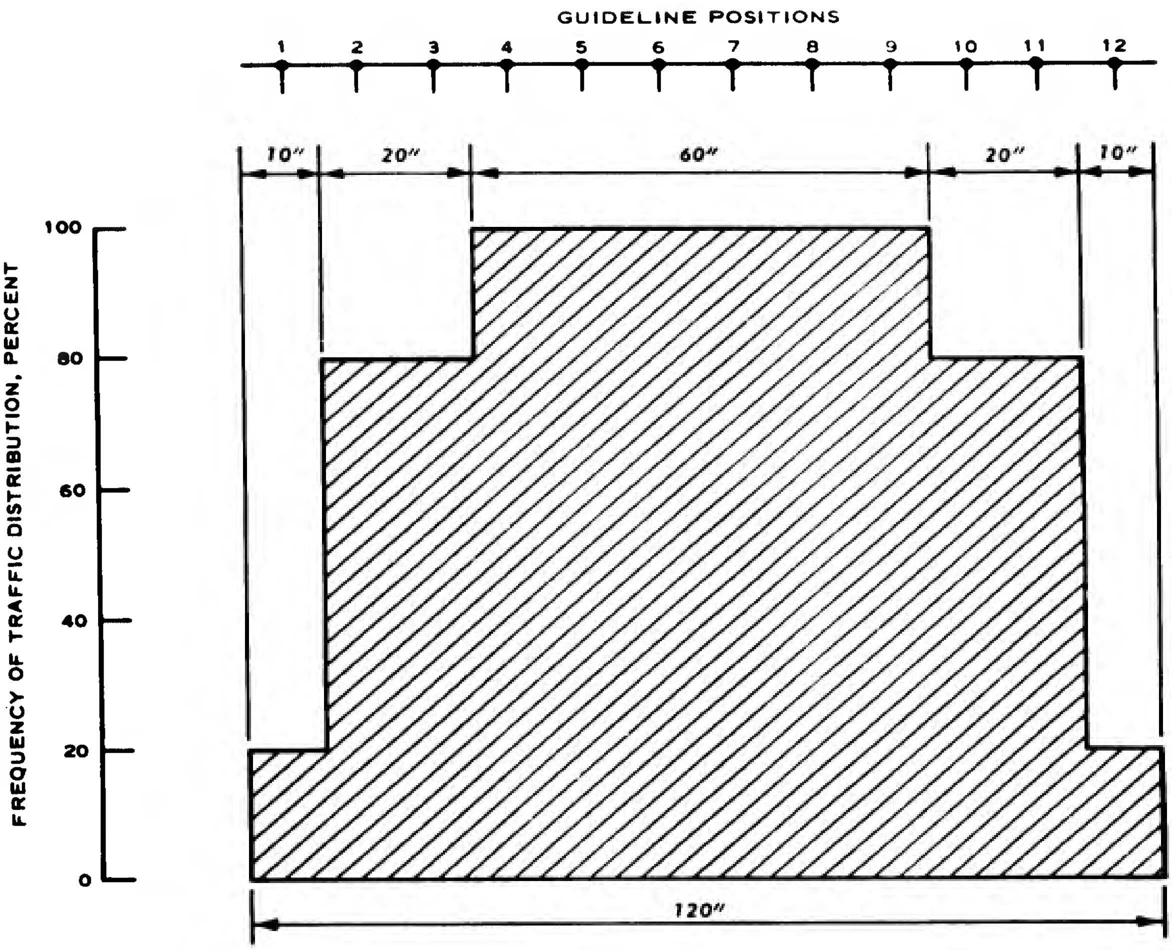


Figure 24. Traffic Distribution Pattern

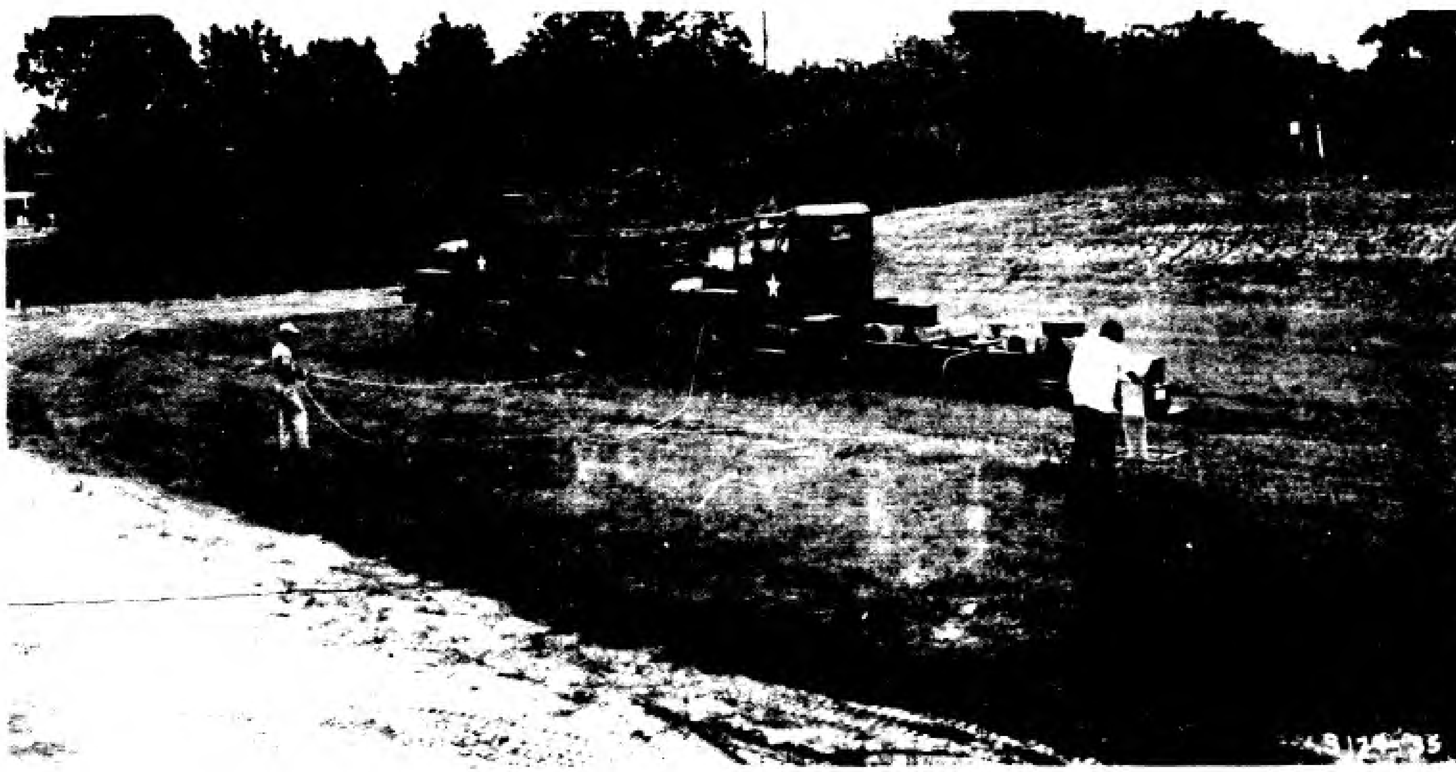


Figure 25. Test Arrangement for Rolling Wheel Drawbar Pull

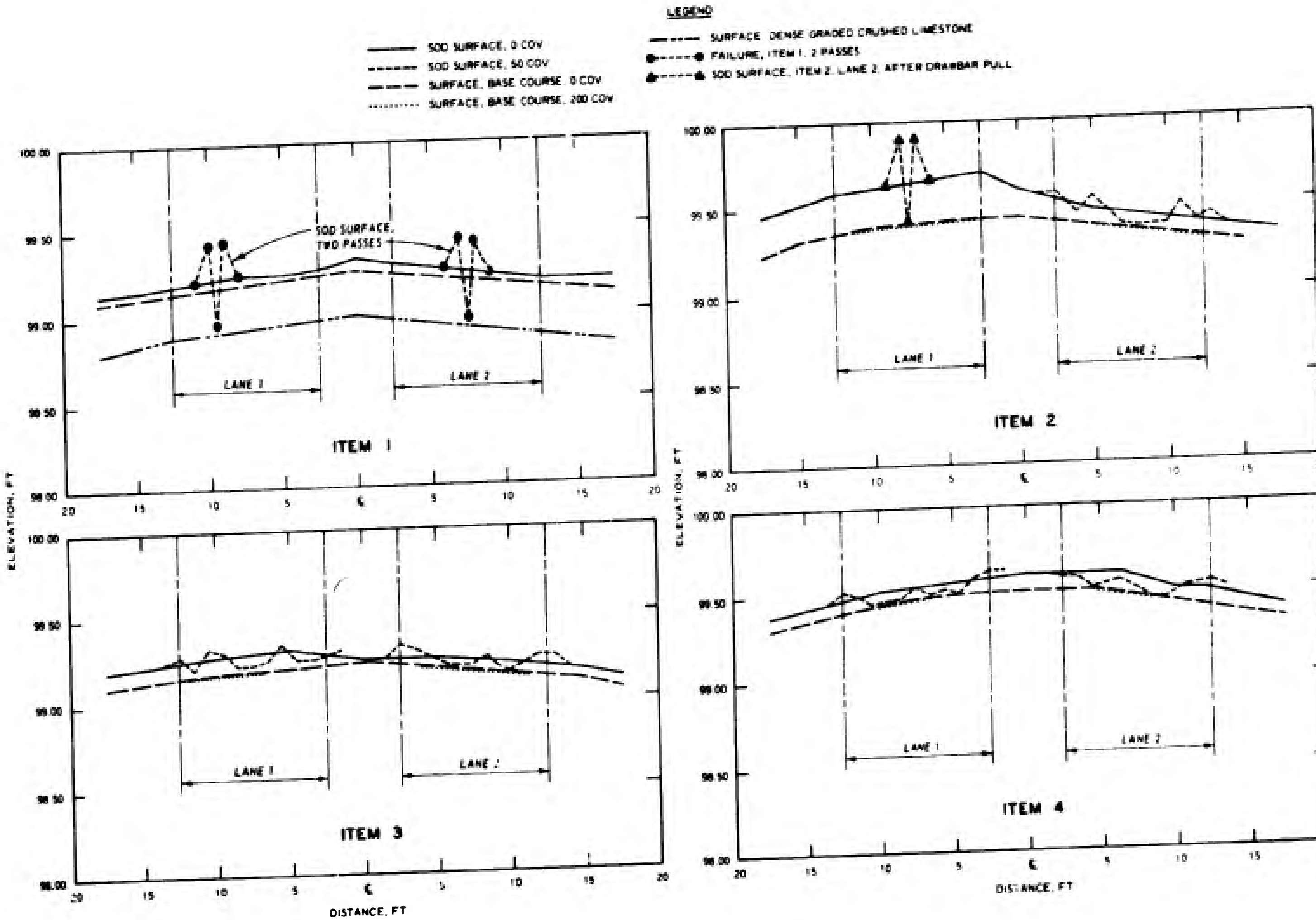


Figure 26. Typical Cross Sections

Figure 27. Item 1, Lane 1, Prior to Traffic

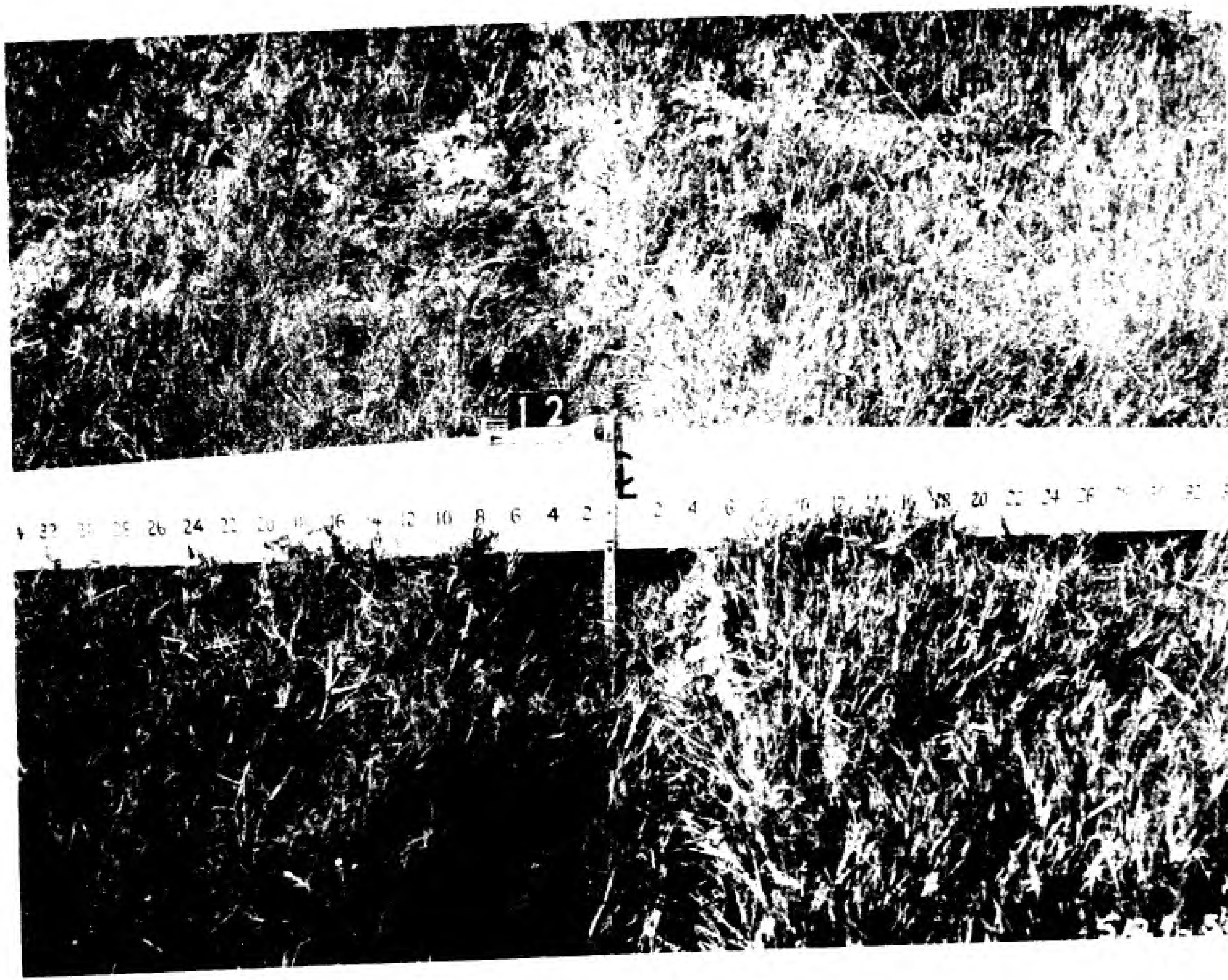


Figure 28. Six-Inch Rut, Item 1, Lane 1, After Two Passes

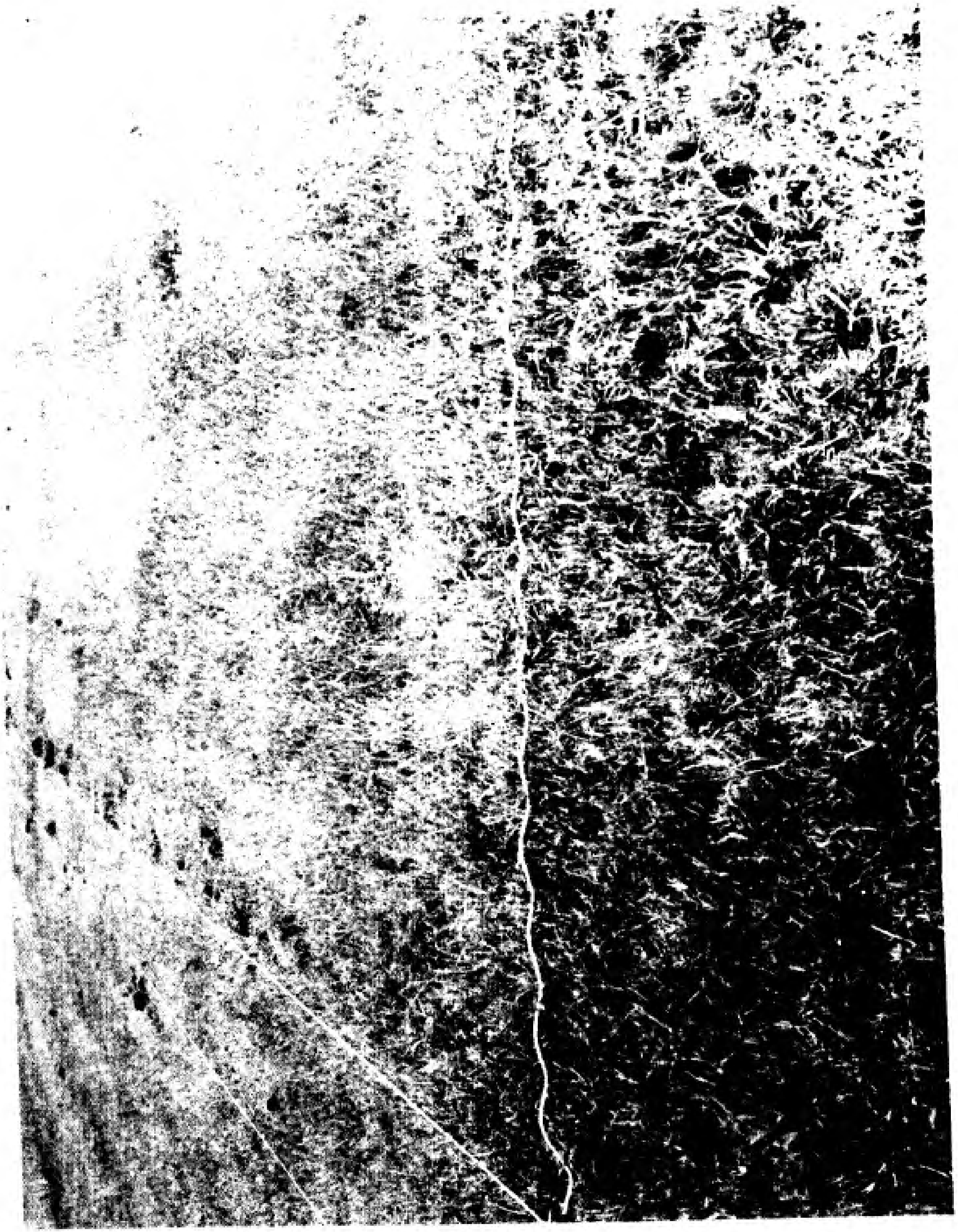


Figure 29. Item 2, Lane 1, Prior to Traffic

Figure 30. Item 3, Lane 1, Prior to Traffic

Figure 31. Item 4, Lane 1, Prior to Traffic

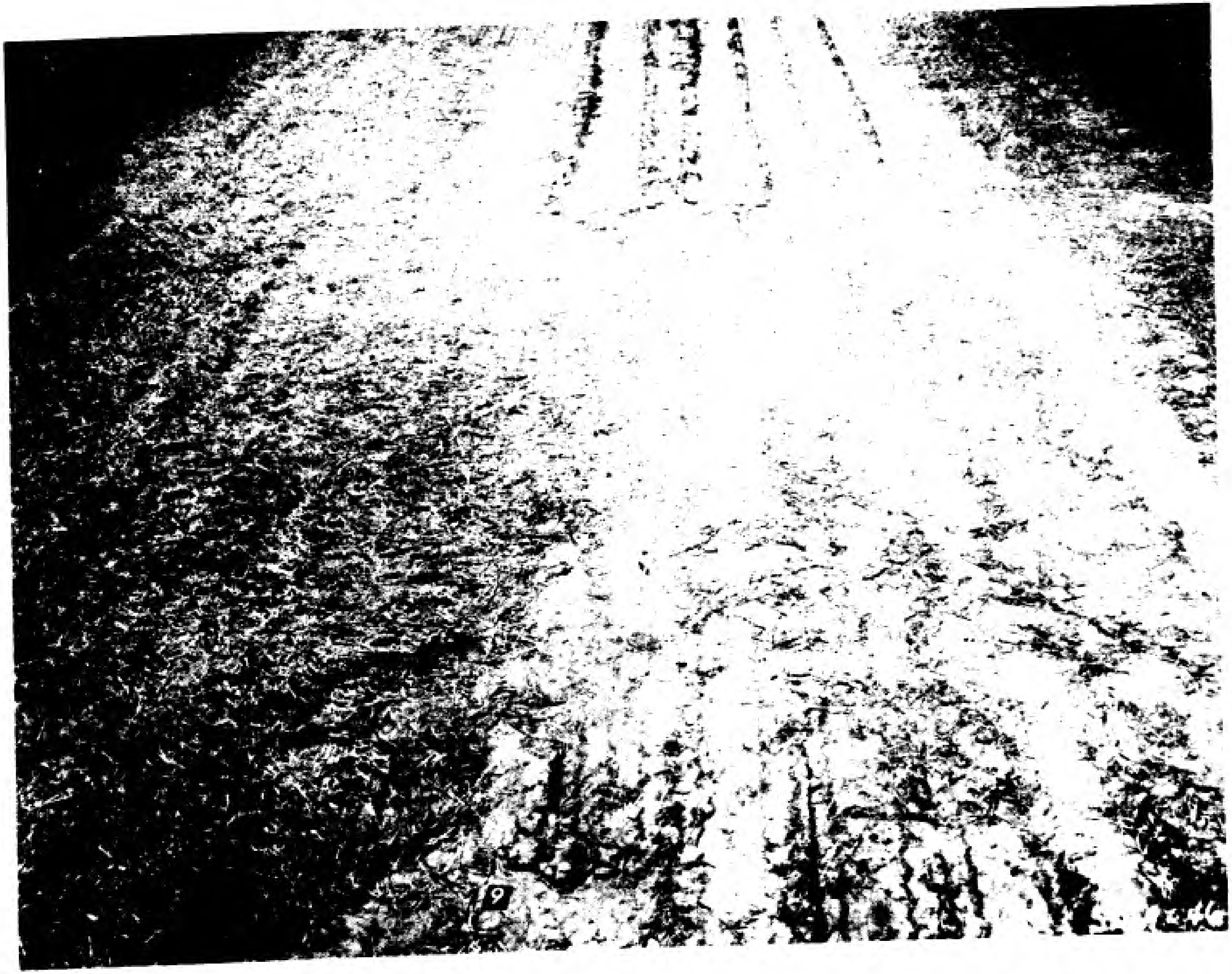


Figure 32. Item 2, Lane 1, After 60 Coverages

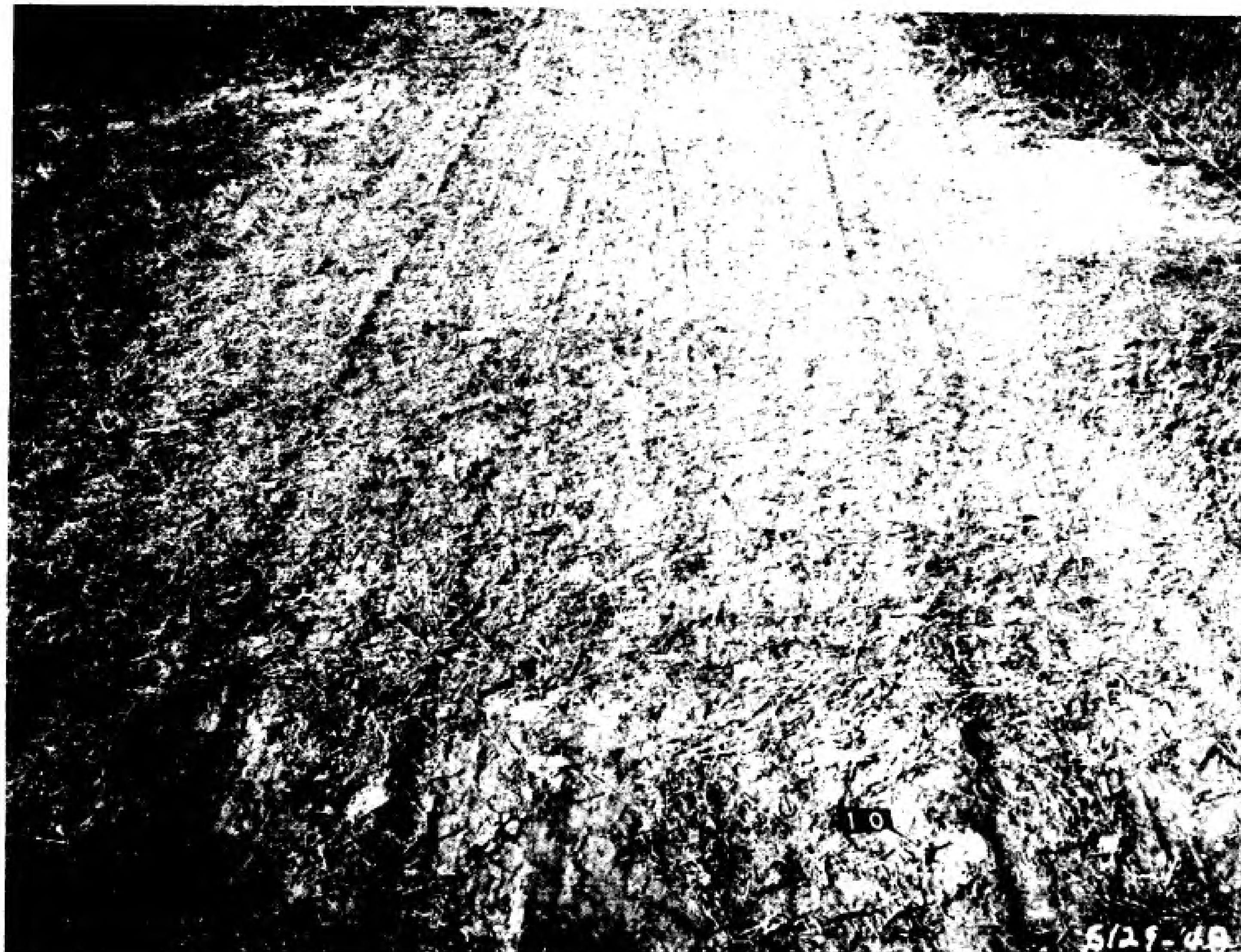


Figure 33. Item 3, Lane 1, After 60 Coverages

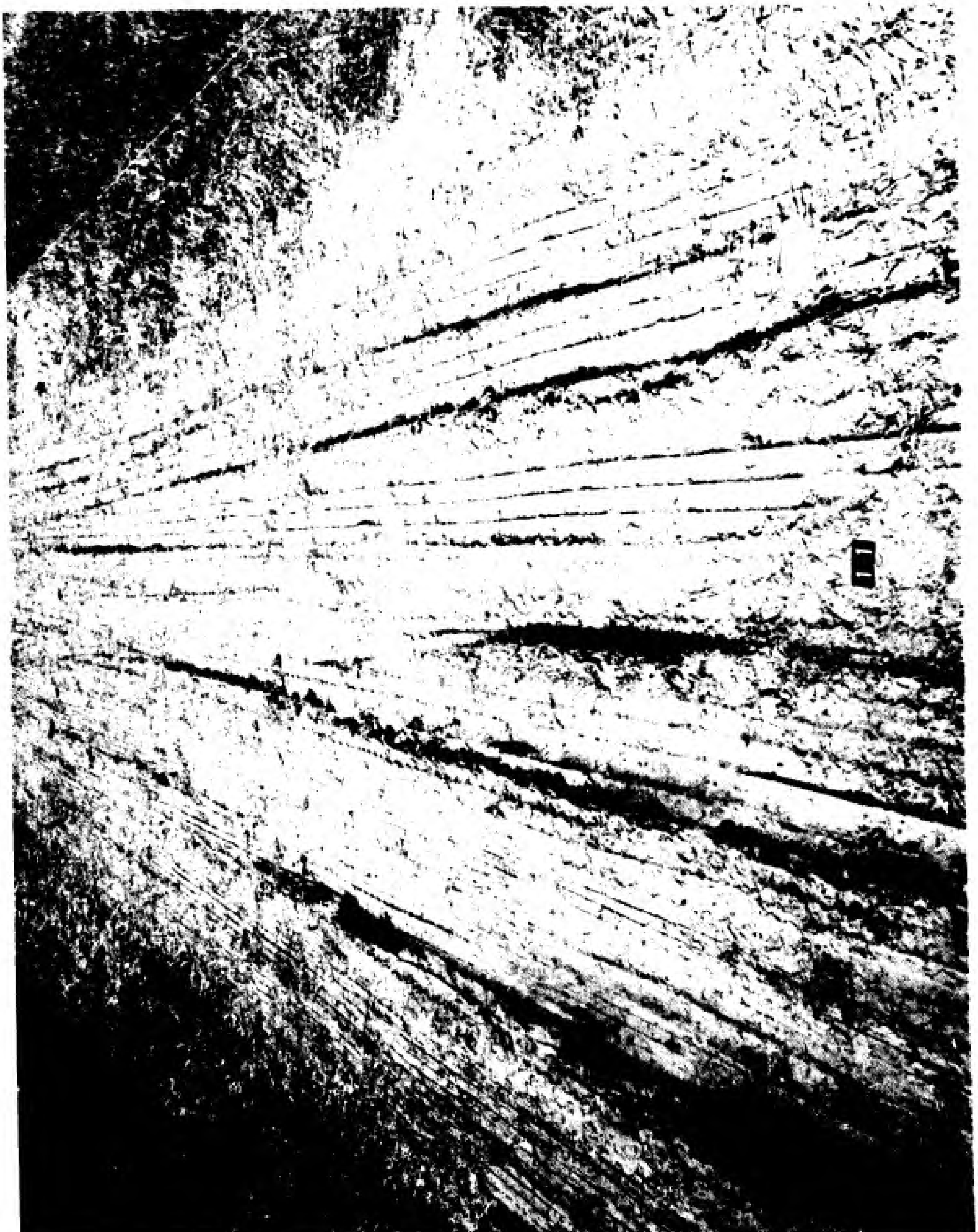


Figure 34. Item 4, Lane 1, After 60 Coverages

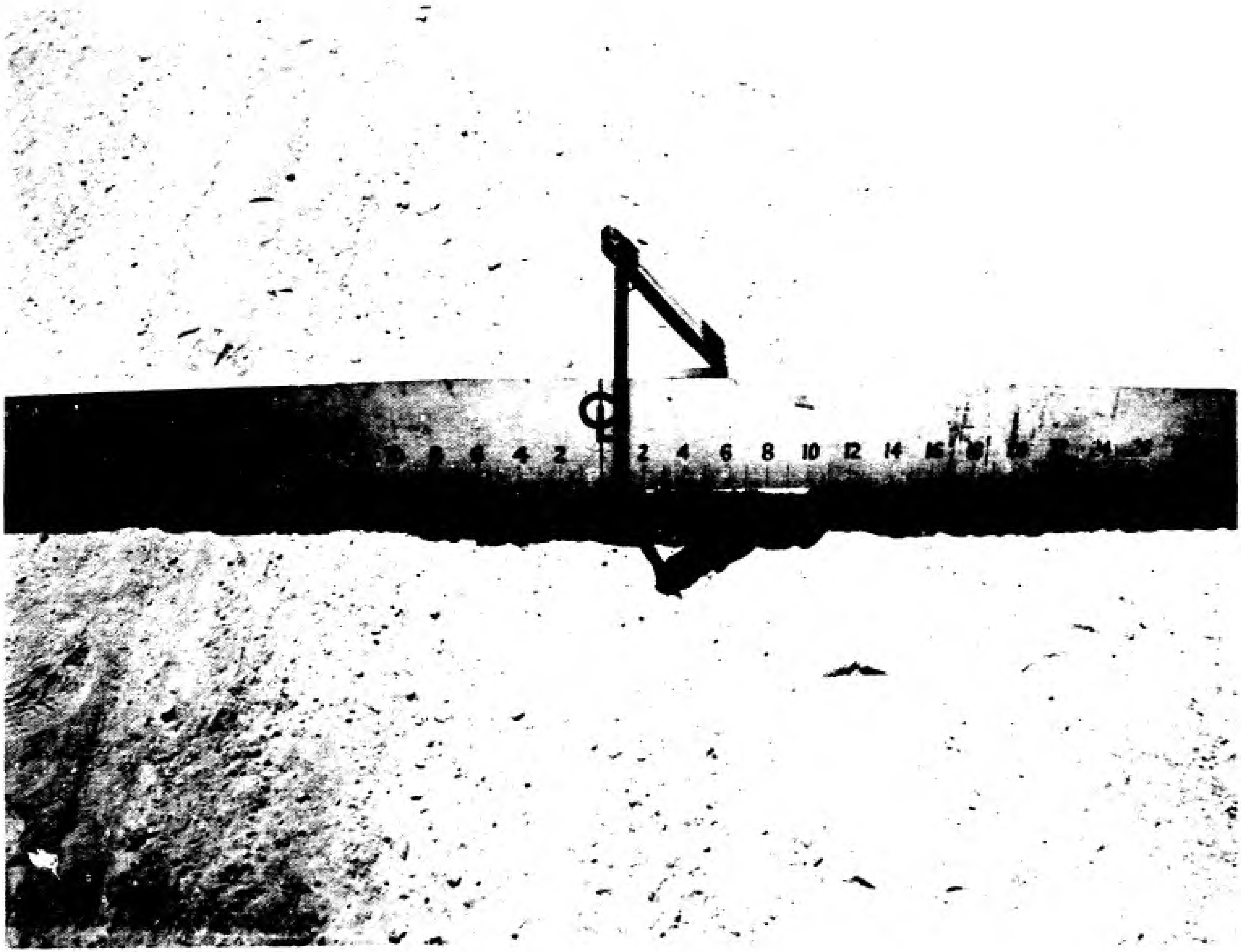


Figure 35. Deformation, Item 2, Lane 1, After 200 Coverages

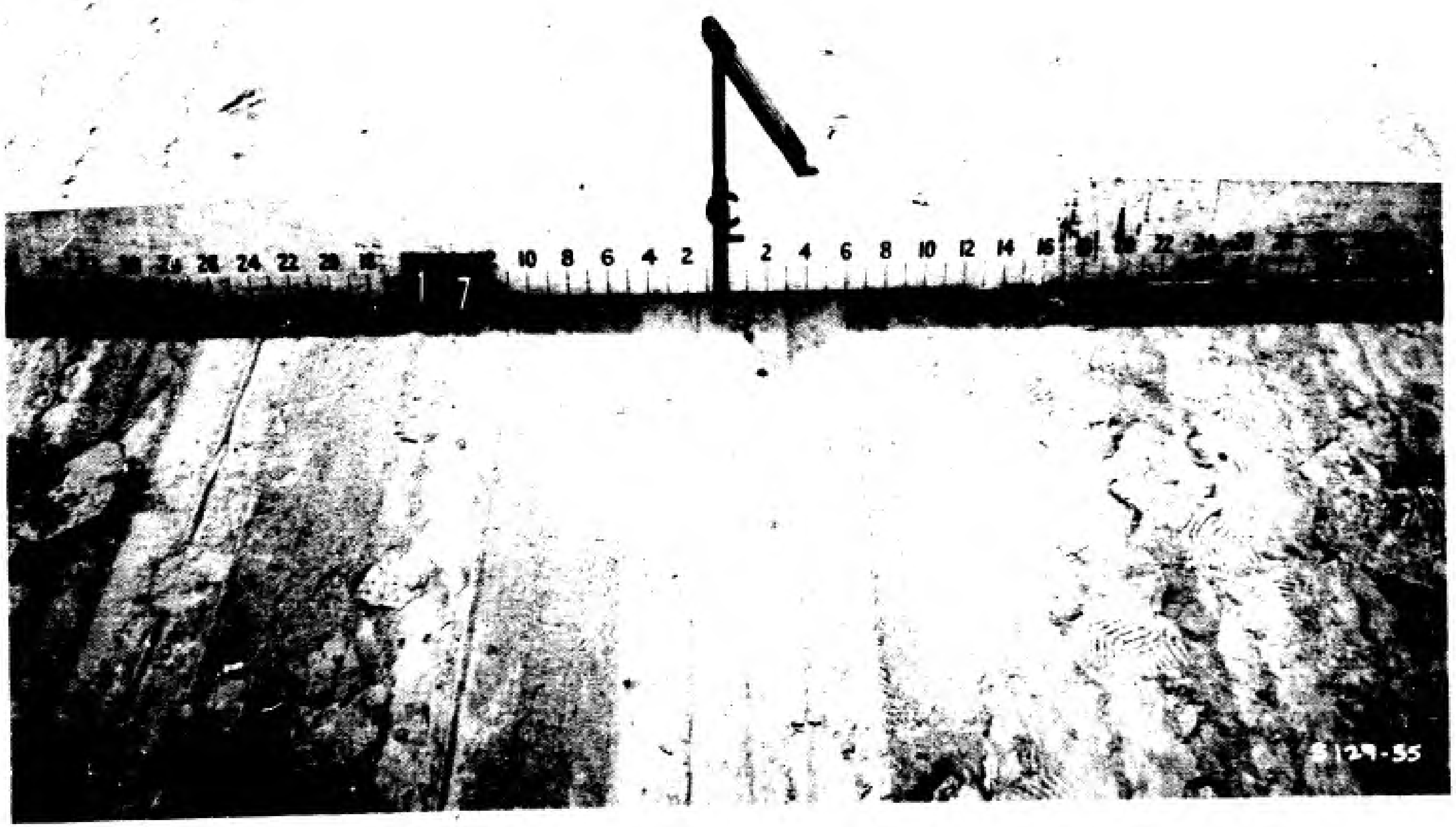


Figure 36. Deformation, Item 3, Lane 1, After 200 Coverages

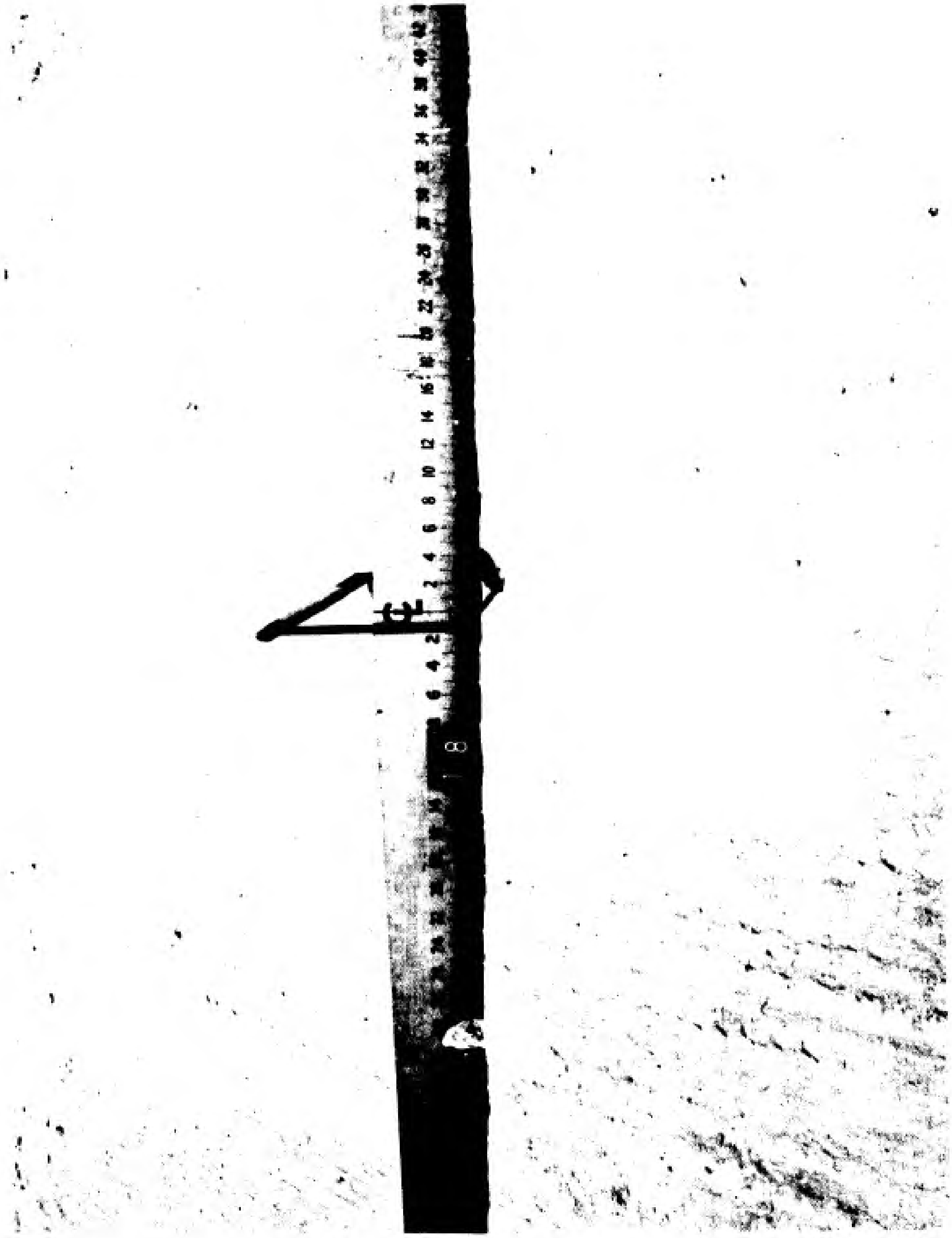


Figure 38. General Condition, Item 2, Lane 1, After 200 Coverages

Figure 39. General Condition, Item 3, Lane 1, After 200 Coverages

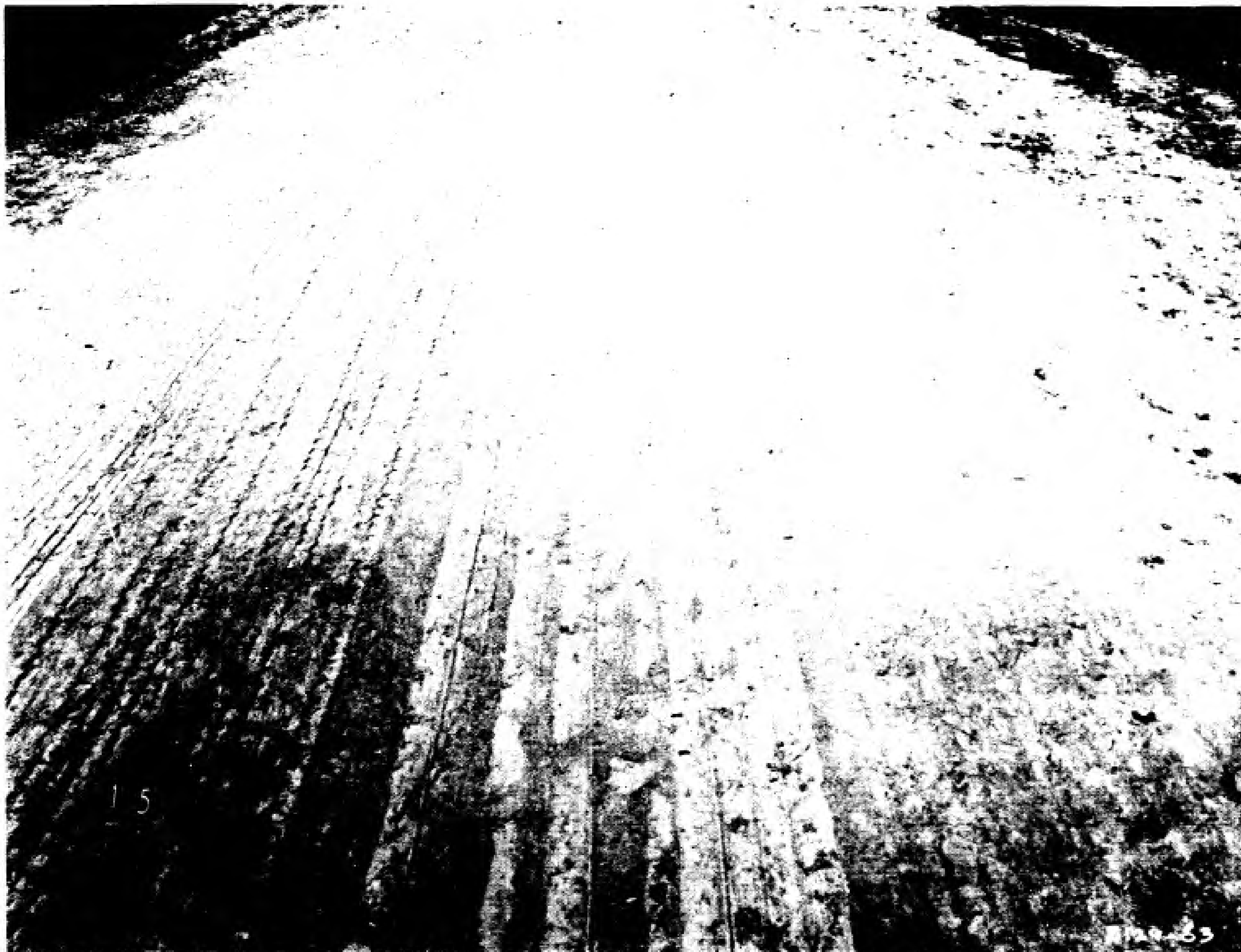


Figure 40. General Condition, Item 4, Lane 1, After 200 Coverages

Figure 41. General View, Lane 2, Zero Coverages

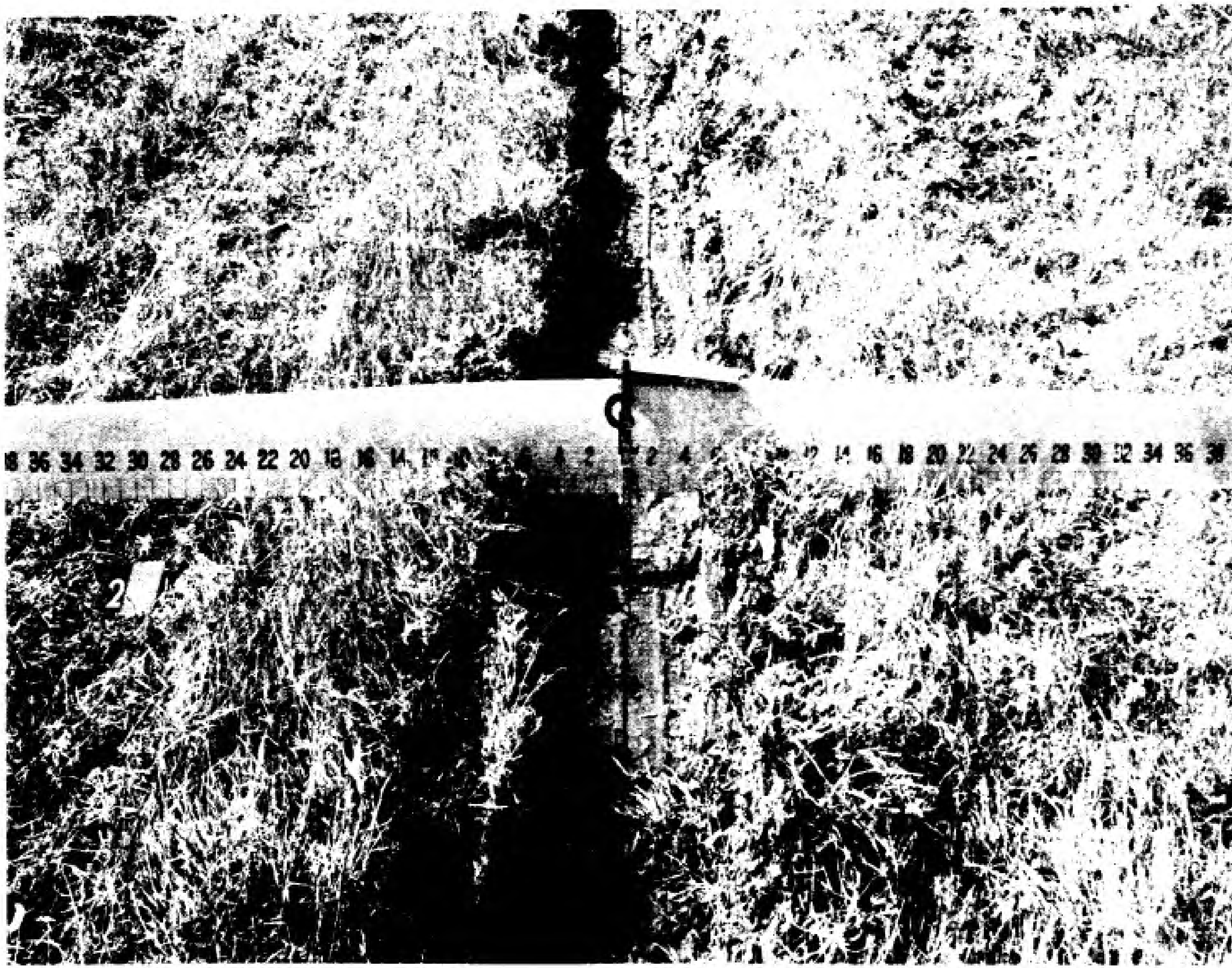


Figure 42. Rut in Topsoil, Item 2, Lane 2, After Drawbar Pull

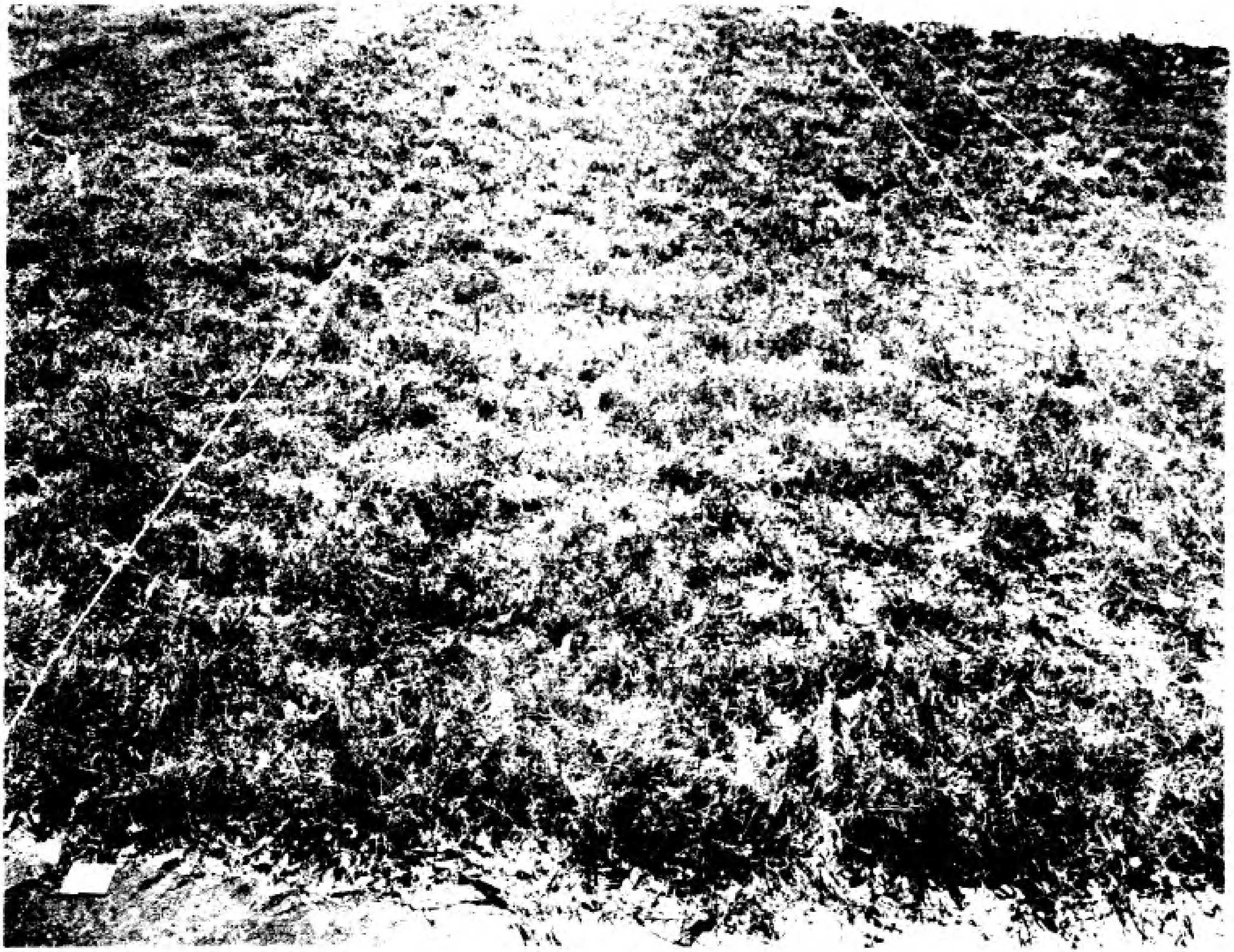


Figure 43. General View, Item 1, Lane 2, Zero Coverages

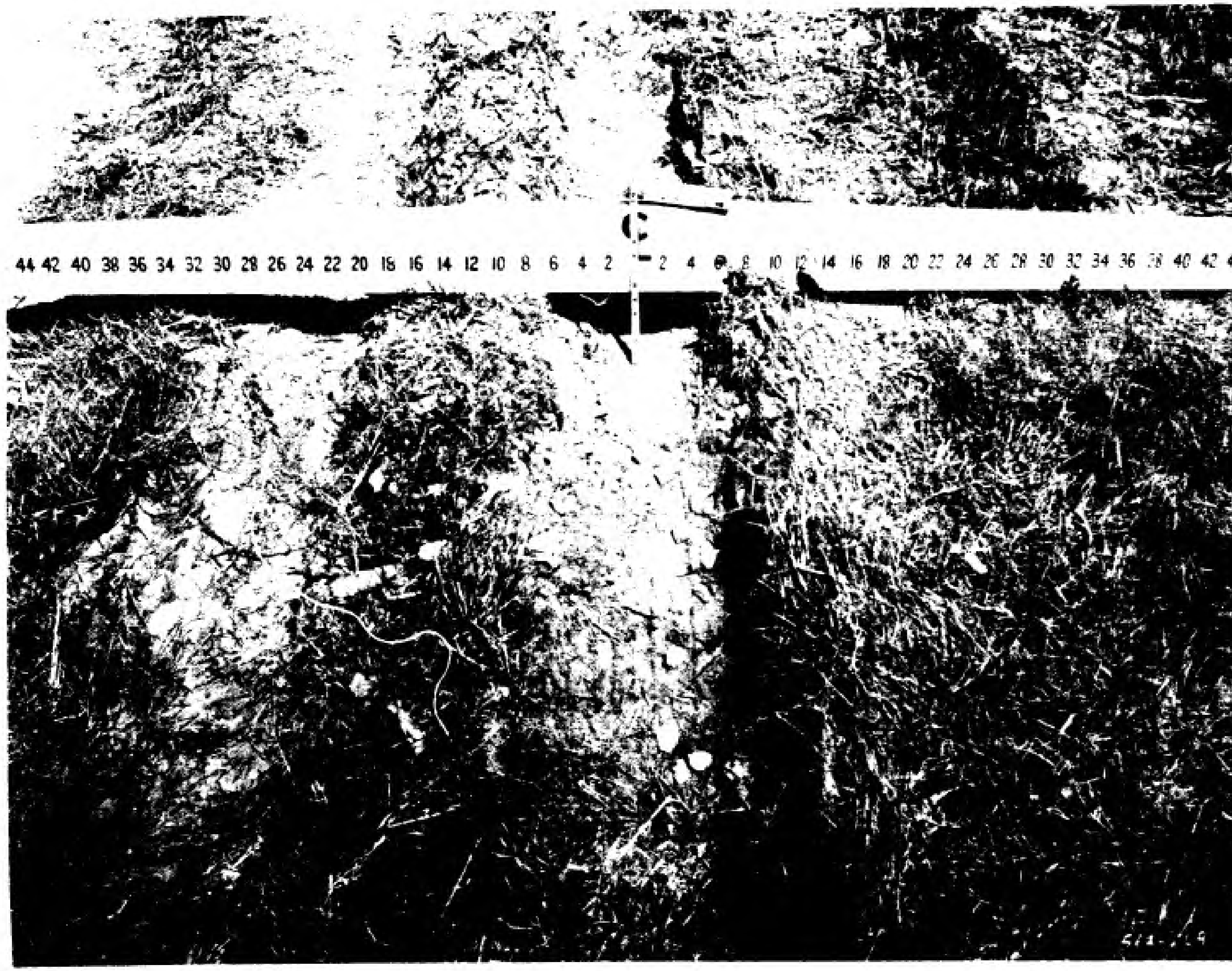


Figure 44. Rut in Item 1, Lane 2, After Two Passes

Figure 45. General View, [illegible]

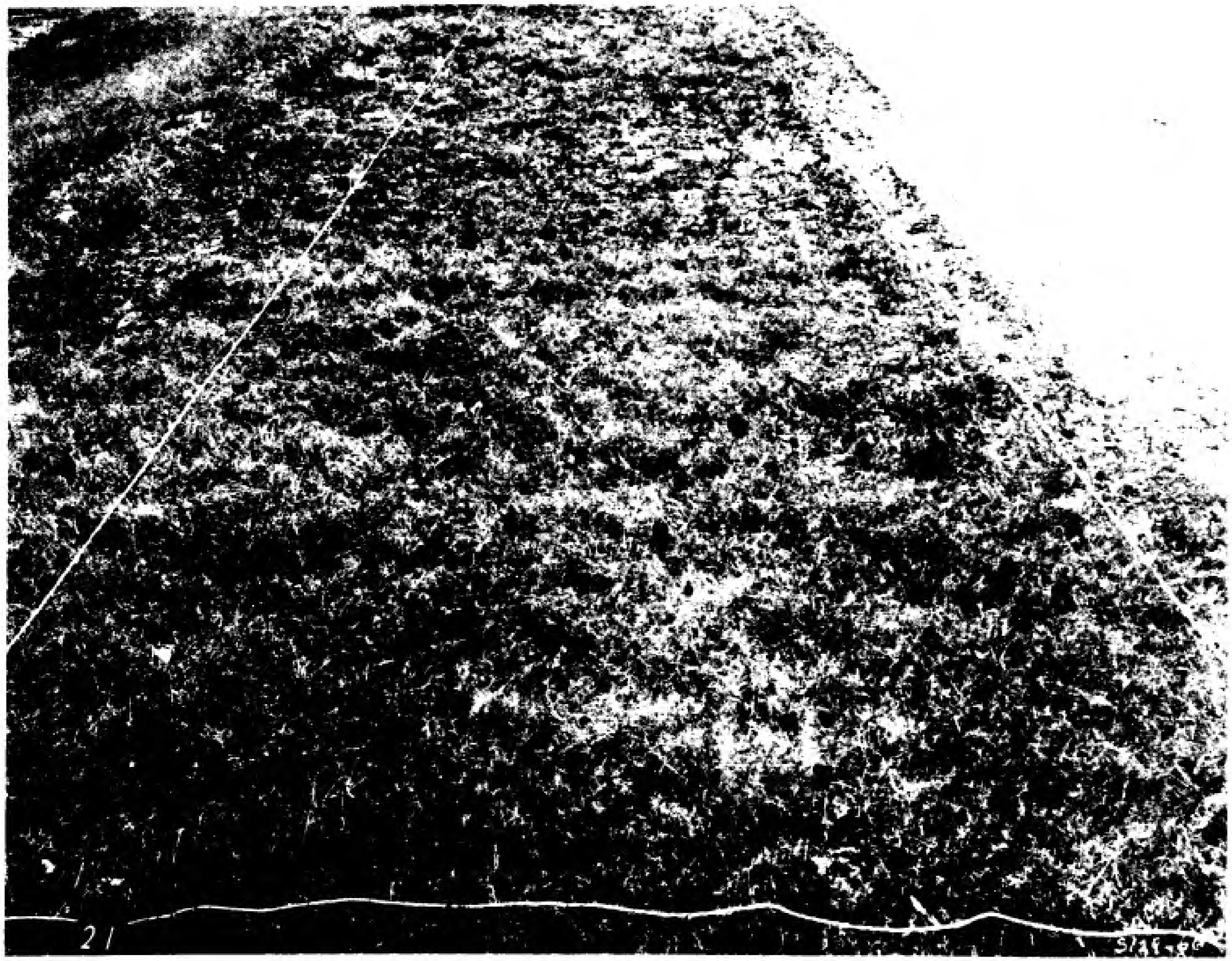


Figure 46. General View, Item 3, Lane 2, Zero Coverages

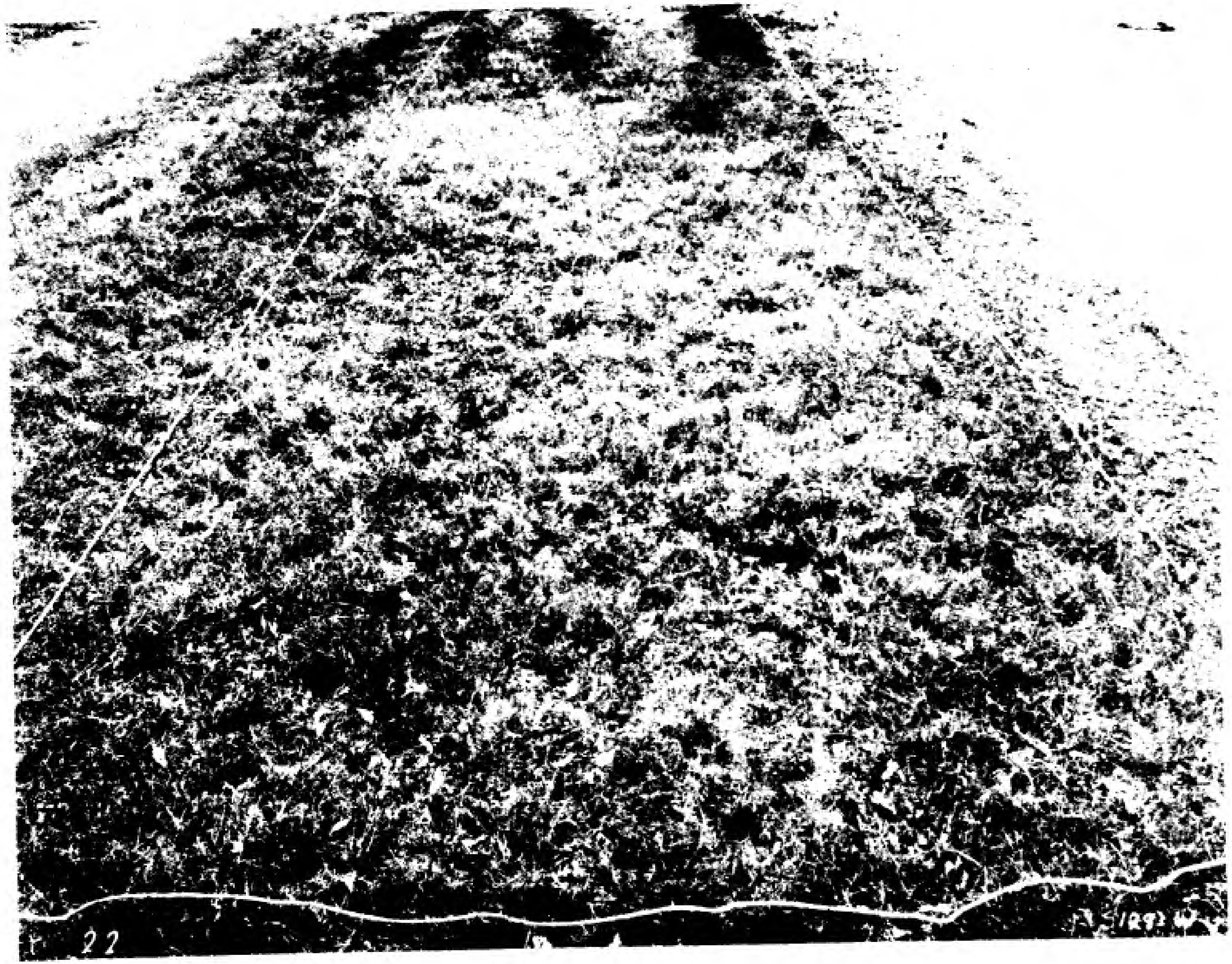


Figure 47. General View, Item 4, Lane 2, Zero Coverages

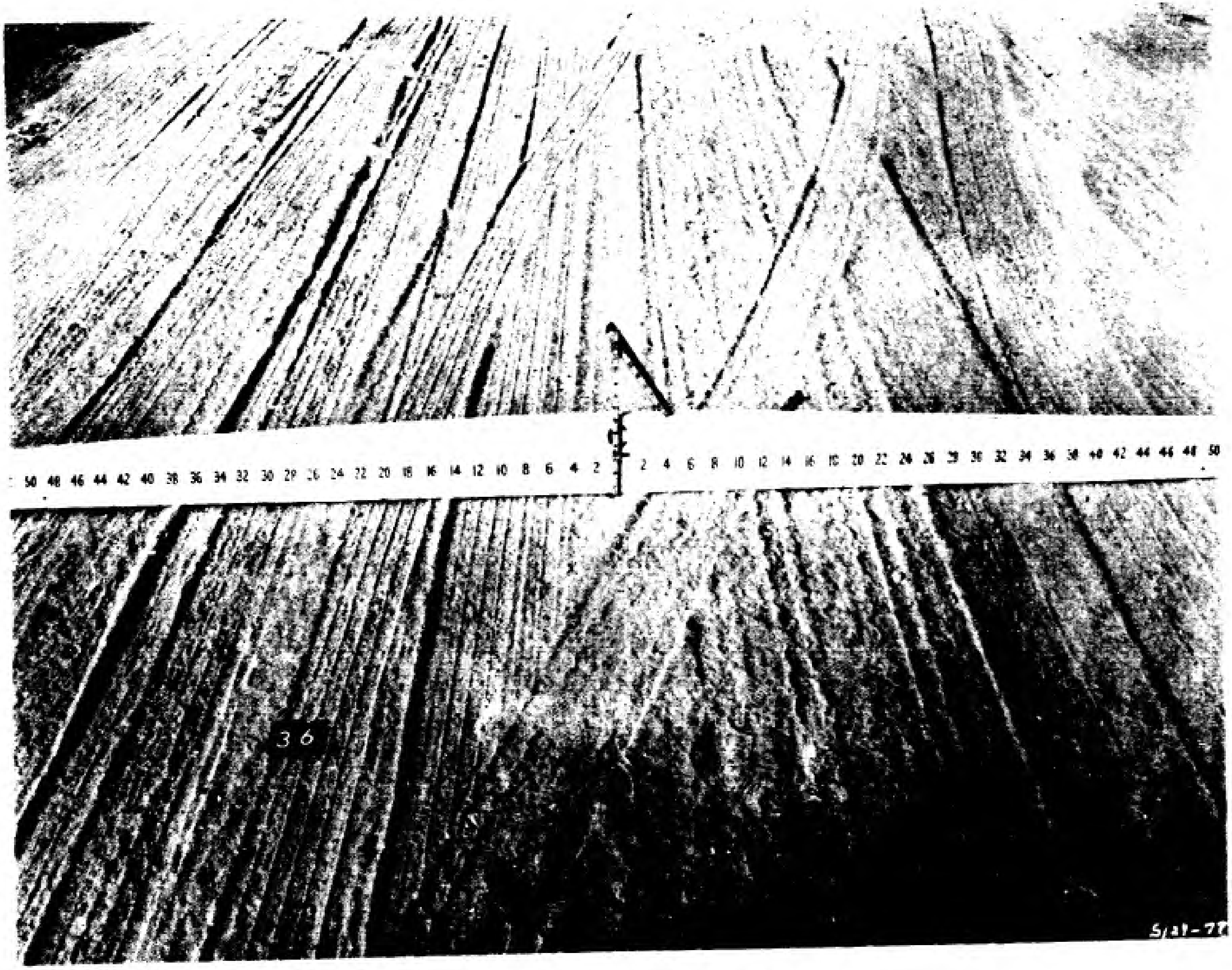
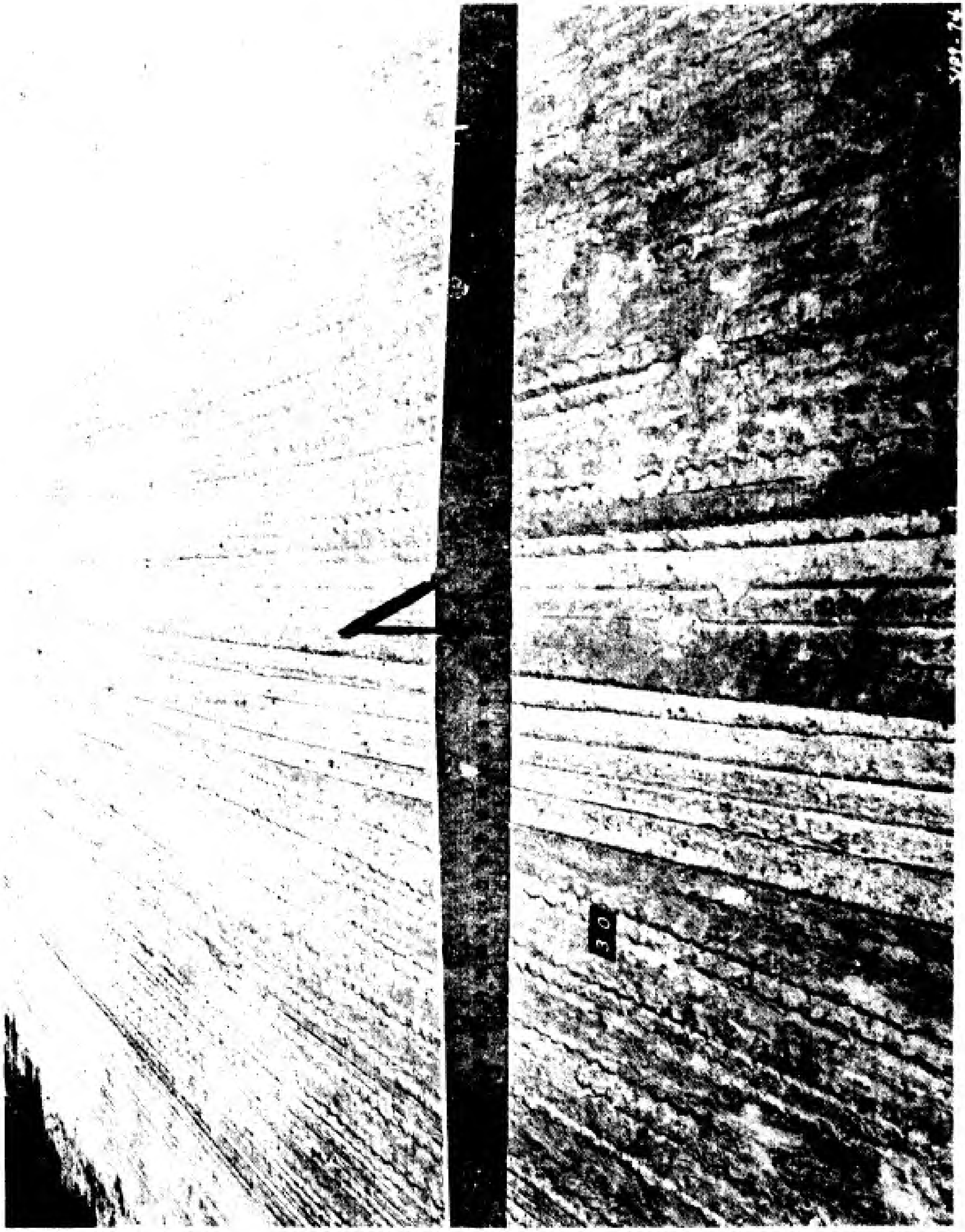


Figure 46. Deformation. Item 2, Lane 2, 200 Coverages



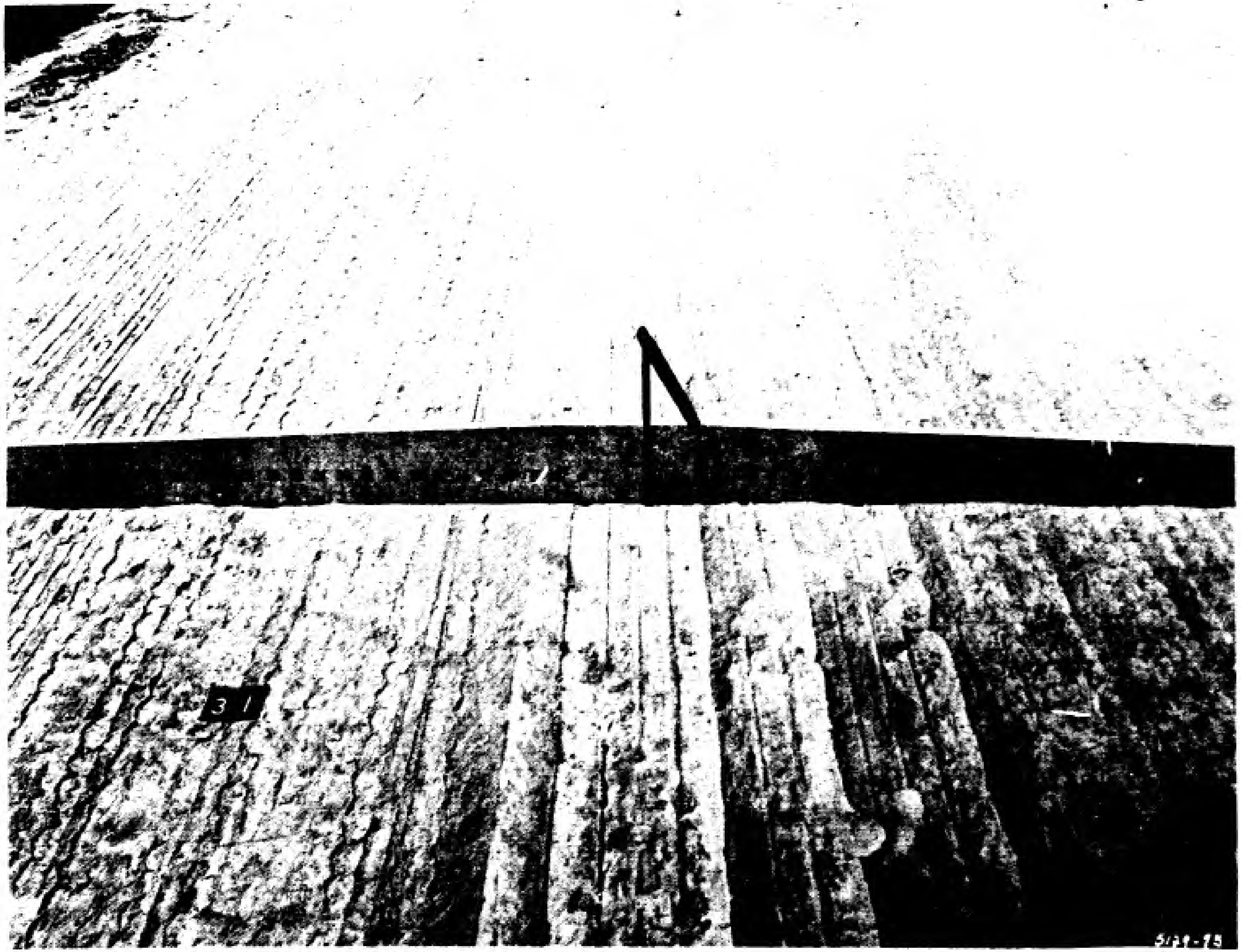


Figure 50. Deformation, Item 4, Lane 2, 200 Coverages

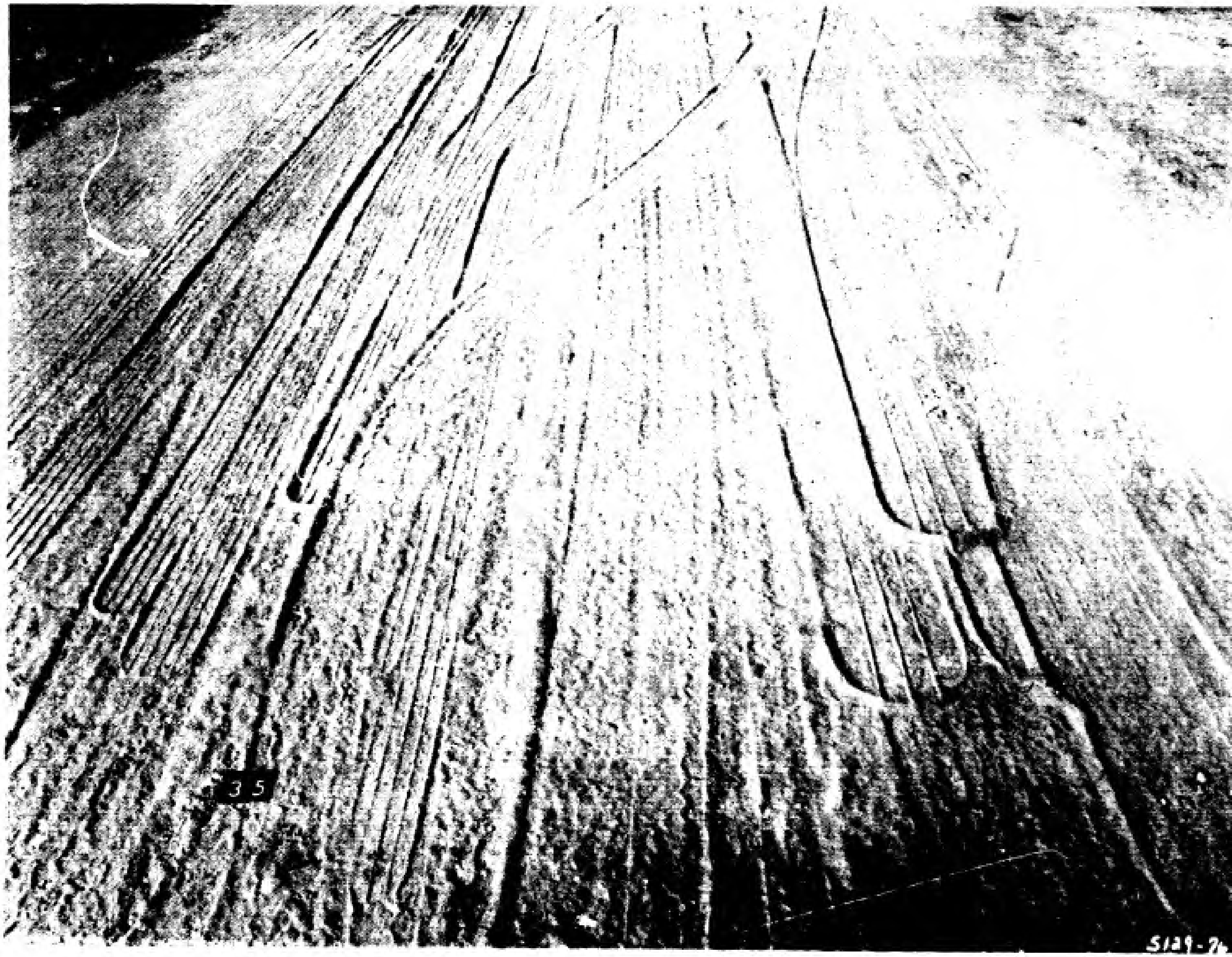


Figure 51. General View, Item 2, Lane 2, After 200 Coverages

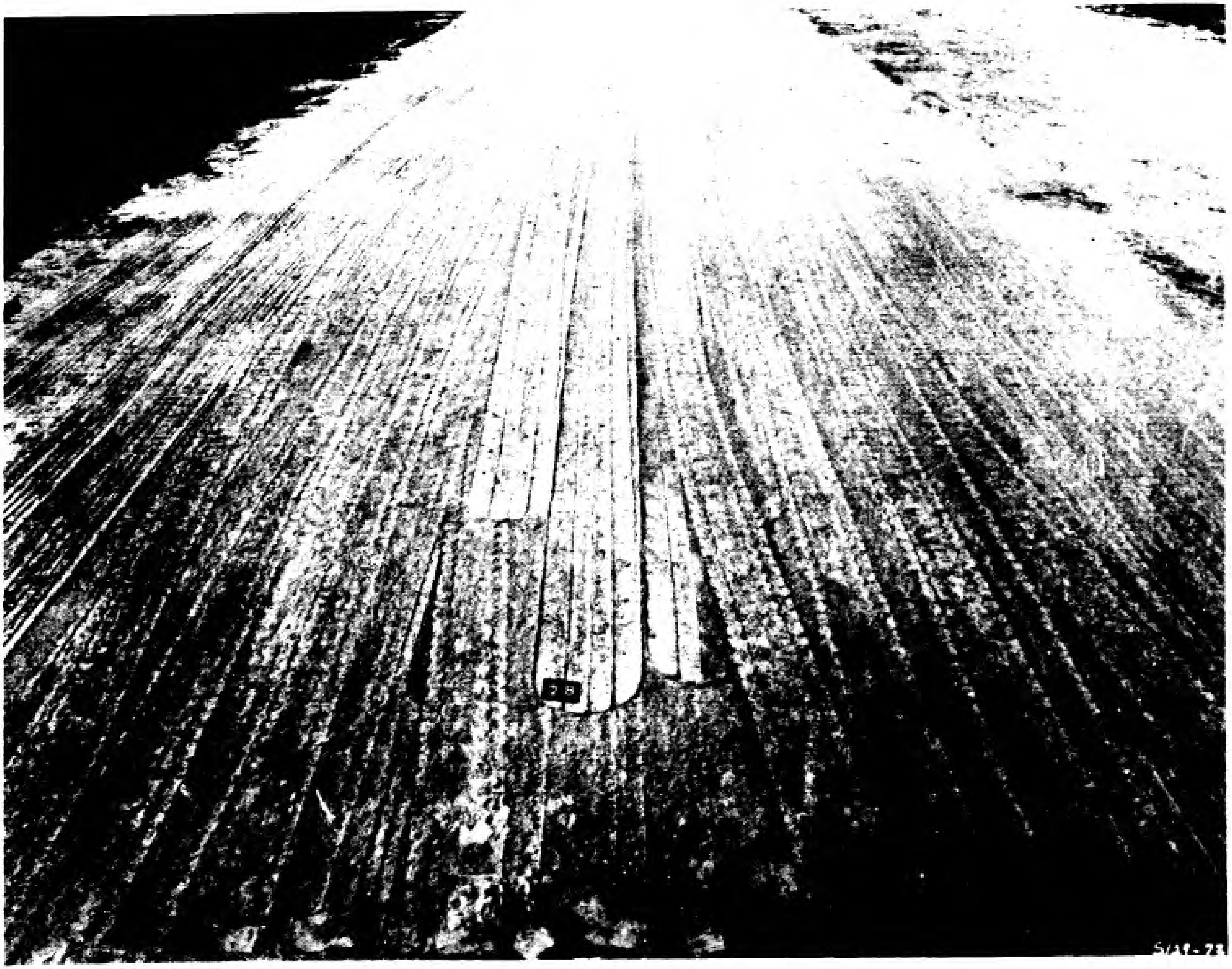


Figure 52. General View, Item 3, Lane 2, After 200 Coverages

Table 1

Summary of CBR, Water Content, Density, and Traffic Coverages

As-Constructed						After Traffic													
						Lane 1							Lane 2						
Item	Material	Depth Below Surface of Layer inches	CBR	Water Content Percent	Dry Density lb/cu ft	Item	Material	Depth Below Surface of Layer inches	CBR	Water Content Percent	Dry Density lb/cu ft	Total No. Coverages	Item	Material	Depth Below Surface of Layer inches	CBR	Water Content Percent	Dry Density lb/cu ft	Total No. Coverages
1	Open-graded crushed stone	Surface	13	--	--	1	Open-graded crushed stone	Surface	10	--	--	2 passes	1	Open-graded crushed stone	Surface	12	--	--	2 passes
	Dense-graded crushed stone	Surface	87	4.4	140.5		Dense-graded crushed stone	Surface	90	3.6	139.9			Dense-graded crushed stone	Surface	80	3.1		
	Lean clay subbase	Surface	12	17.3	102.9		Lean clay subgrade	Surface	10	18.6	105.3			Lean clay subgrade	Surface	10	18.3	104.5	200
		6	10	17.7	100.9			6	12	18.0	105.0				6	7	21.6	94.3	
		12	7	22.0	87.0			12	7	22.7	85.6				12	6	23.3	90.1	
2	Stabilized sandy gravel	Surface	150+	4.8	130.1	2	Stabilized sandy gravel	Surface	261	4.8	132.5	200	2	Stabilized sandy gravel	Surface	210	4.1	131.9	200
	Lean clay subgrade	Surface	13	17.0	102.2		Lean clay subgrade	Surface	10	19.3	103.4			Lean clay subgrade	Surface	12	17.7	105.8	
		6	8	17.5	101.7			6	12	18.5	103.4				6	7	21.1	96.7	
		12	7	23.7	84.0			12	6	24.0	83.4				12	9	22.2	94.1	
3	Stabilized lean clay	Surface	116	14.5	99.6	3	Stabilized lean clay	Surface	198	14.0	102.1	200	3	Stabilized lean clay	Surface	175	18.3	100.1	200
	Lean clay subgrade	Surface	10	17.7	101.5		Lean clay subgrade	Surface	12	19.4	104.0			Lean clay subgrade	Surface	11	18.0	104.7	
		6	10	17.1	101.3			6	10	19.5	102.2				6	10	19.2	104.5	
		2	13	18.0	102.3			12	13	18.5	102.5				12	11	19.4	102.9	
4	Stabilized clayey gravel	Surface	31	9.3	125.6	4	Stabilized clayey gravel	Surface	135	6.0	127.5	200	4	Stabilized clayey gravel	Surface	144	6.1	128.0	200
	Lean clay subgrade	Surface	12	17.0	102.5		Lean clay subgrade	Surface	12	17.0	105.5			Lean clay subgrade	Surface	13	18.0	106.0	
		6	11	18.1	102.2			6	11	18.0	100.8				6	10	17.7	101.1	
		12	15	19.0	104.0			12	16	18.9	105.1				12	10	18.0	102.3	

Table 2

Rolling-Wheel Drawbar Pull

Sod Surface in Place				Sod Surface Removed			
		Force in Pounds				Force in Pounds	
Lane	Item	Peak at Start	Rolling	Lane	Item	Peak at Start	Rolling
1	1	7,700	3,700	1	1	--	--
	2	4,500	2,000		2	1,800	900
	3	4,400	1,800		3	2,100	900
	4	3,200	1,500		4	2,300	1,000
2	1	10,000	5,900	2	1	--	--
	2	7,000	4,000		2	1,600	900
	3	4,000	1,700		3	2,200	900
	4	3,900	1,800		4	2,100	900

Table 3

Laboratory Data on Stabilized Materials

Material	Compactive Effort	Tested Immediately After Molding			Tested 7 Days After Molding Humidity Cured			Tested 21 Days After Molding Humidity Cured			Tested After 3 Days Humidity Curing Plus 4 Days Soaking			Tested After 7 Days Humidity Curing Plus 4 Days Soaking		
		Water Content After Testing	Density lb/cu ft	CBR	Water Content After Testing	Density lb/cu ft	CBR	Water Content After Testing	Density lb/cu ft	CBR	Water Content After Testing	Density lb/cu ft	CBR	Water Content After Testing	Density lb/cu ft	CBR
Item 2—sandy gravel with 5 percent portland cement	CE-55	4.5	131.0	98	3.4	132.6	1700	3.1	132.3	1890	7.0	130.1	1620	6.6	132.6	1873
Item 3—lean clay with 12 percent portland cement	CE-12	13.9	100.0	45	13.3	101.6	197	12.1	102.2	237	22.5	100.4	212	22.5	101.0	183
Item 4—clayey gravel with 4 percent lime	CE-55	9.4	128.1	41	9.1	127.6	104	7.7	127.6	168	9.6	126.8	93	10.1	126.7	82

APPENDIX A

OCCURRENCE OF CONSTRUCTION MATERIAL FOR CONTINGENCY RUNWAYS

PURPOSE AND SCOPE

The purpose of this appendix was to establish the types of construction material that are available in Europe, the Middle East, and the Far East and to determine the general classification of the subgrade soils in the above-mentioned geographic areas that will be encountered in contingency runway construction. Because of the vast area included in the geographic regions and the fund constraints, the scope of this phase was reduced to a few selected countries in each region.

APPROACH

The approach used for this study was to:

1. Select countries with each geographic region.

2. Identify the soil and rock classes of interest.

3. Map these soil and rock classes with selected countries using a readily available data source.

4. Determine the area occupancy and frequency of occurrence of the soil and rock classes within each country.

SELECTION OF DATA BASE COUNTRIES

A list of countries was compiled where the probability for contingency runways is high. The total number of countries exceeded the fund allocation and was prioritized. Work was concentrated on the first priority countires with remaining time and funds devoted to the second priority countries. The countries by priority are presented in Figure A1. Although this report included only the data generated for the first priority countries, mapping on some of the second priority countries was carried to various stages of completion.

CLASSIFICATION OF SUBGRADE MATERIAL

A classification system was selected to identify the types of subgrade material that occurred in the selected countries. This system included three factors: soil types, rock types, and rock hardness. Data to identify these factors were extracted from existing sources, and small-scale mapping was used because of the geographic area covered by the selected countries coupled with the time-fund limitations. Uniformity of data between countries was also desirable. Based on past experience and knowing the readily available sources of geological and soils data for the countries selected, the National Intelligence Survey (NIS) was the only logical data source to use for this study.

The NIS has prepared classified reports for practically all countries of the world which include information on soils and rocks. Scales of presentation for each NIS report vary, but practically all maps generated are small scale (<1:600,000). The NIS maps identify soils in terms of the Unified Soil Classification System (USCS), and rock types are generally divided into igneous, metamorphic, and sedimentary. Each rock class is generally broken down into specific rock, depending upon its data sources. A qualitative determination of hardness is included for the rock types mapped.

Descriptive terms or classes were selected for each factor using the NIS's as a guide. The soil classes are presented in Figure A2, and the rock type and hardness characteristics are presented in Figure A3. Rock types were mapped only where rock occurred within 20 feet below the surface.

FACTOR MAPPING

Factor mapping can be defined as the preparation or construction of a map that shows the areal distribution of factor classes.

The NIS maps were used as data for constructing factor maps. Because legend format used by the NIS is not identical to the map units selected for this study, a conversion had to be made. In some instances, NIS uses somewhat different legends between countries, and the conversion process had to be done for each individual NIS to the legends for this study. The product of the conversion was in each case a pairing of the NIS legend with its approximate equivalent. After all necessary conversions had been made, the next step was to construct a map for each of the three factors for all the data base countries. This map was simply a graphic isolation of areas that exhibit the same characteristics as described by factor classes or map units. Each of the outlined areas was identified by a number that corresponded to a map unit. The rock type and hardness were compiled on a single map. After all maps for a specific country had been constructed, they were combined into a single map, which is designated a factor complex map. The procedure for compiling a factor complex map is to overlay the soil type, rock type, and rock hardness in that order on a single base map. After these maps have been superposed, all boundaries are traced into a new base. Each area (or patch) thus delineated is identified by an array of three numbers, designating the factor class of soil type, rock type, and rock hardness. To simplify the identification of factor complexes, these three-number arrays were computer tabulated, and a number was assigned to each different array. A master legend was constructed listing all combinations of the class ranges for the three factors that occurred in the data base countries (see Figure A4). A total of 134 unique combinations of map units of the three factors resulted. Each unique combination is a factor complex type. The final factor complex map for the first priority countries is presented as Plates A1-A9, furnished under separate cover (CONFIDENTIAL). The soil type maps of the countries are presented as Plates A10-A18. The rock type and rock hardness are presented as Plates A19-A27. England, Scotland, and Wales are on a single map for each map presented. These plates are classified because of the data source.

COMPUTATION AND PRESENTATION OF DATA

Factor complex types were analyzed for area occupancy and frequency of occurrence for the first priority countries. Input data for area occupancy required that each patch (an outline area identifying a factor complex type) on all the factor complex maps be measured. This was accomplished by physically measuring each outlined area with an electronic digitizer. This instrument was operated by setting the map scale in the machine and tracing the outline of a specific factor complex patch, and the area within the patch outline appeared on a display board on the machine in square kilometres. The measured patch was identified by country, factor complex, and area on a computer form. This process was continued until all patches within all the data base countries were measured. A computer program was written that summed the areas of each unique factor complex and sorted the factor complexes from minimum to maximum area occupancy. The frequency of occurrence of each factor complex was obtained by counting each terrain patch of the same factor complex, and a list was printed of the number of patches for each factor complex and sorted from minimum to maximum number. A sort was also made sequentially by factor complexes or map units. The number of patches and area occupancy of each factor complex within the data base countries was also sorted sequentially by map unit. These data are presented in Tables A1-A4.

All data shown in the tables are not self-explanatory; therefore, it may be desirable to explain each table even though duplication and self-explanatory items are involved. The title of the table identifies whether the factor complexes are sorted numerically, or on the basis of area, or number of patches.

TABLE A1, COLUMN 1, MAP UNIT

This number represents a factor complex array of four numbers. This number was derived from tabulating the factor complex arrays starting with the lowest real number resulting from a factor complex array which identifies the map class of soil type, rock type, and rock hardness (in that order). For example, in Table A1 factor complex array 1021 is the lowest number, so it was identified as map unit 1, 1031 was identified as map unit 2, etc. The principal use for map units is for the portrayal of factor complexes on a map when you substitute one, two, or three digits for four digits for space reasons and for more expedient correlations of the occurrence of factor complexes between countries.

COLUMN 2, FACTOR COMPLEX

As previously stated, this is a four-digit number that represents the factor class for soil types, rock type, and rock hardness (in that order). For example, a factor complex 1021 translated means that the terrain has a soil type GW,GP (factor class 1), rock type igneous intrusive (factor class 02), and the rock characteristic is hard (factor class 1).

COLUMN 3, TOTAL NOP

This column identifies the total number of patches of the factor complex that occur within all the data base countries.

COLUMN 4, TOTAL AREA

This column identifies the area occupied by all patches of a factor complex within all the data base countries.

COLUMNS 5, 6, 7, ETC.

These columns identify the countries not by names used as data input. Under each country are two columns, NOP and area, which identify the number of patches of a factor complex and the total area occupied by the patch(es), respectively, within a country.

TABLE A2

Columns 1, 2, 3, and 4 are the same as those on Table A1.

COLUMN 5, PERCENT

This column identifies the percent of the total number of patches of a factor complex.

COLUMN 6, ACCUMULATIVE PERCENT

This column keeps a running total of the percent of number of paths of factor complexes starting with map unit 1 and continuing until 100 percent is reached with map unit 134.

COLUMN 7, PERCENT OCCUPANCY

This column identifies the percent of the total area occupied by a factor complex.

COLUMN 8, ACCUMULATIVE PERCENT

This column keeps a running total of percent occupancy of factor complexes starting with the factor complex with the map unit 1 occupancy and continuing until 100 percent is reached with map unit 134.

TABLES A3 AND A4

These tables contain the same data as Table A2 except they were sorted differently and should be self-explanatory.

DATA ANALYSIS

To satisfy the purpose of the study, an analysis of the area occupancy of soil types and rock types was made. This analysis identified the subgrade and construction material that occur in the study countries. The area distribution of these materials can be determined from the factor complex maps.

Figure A5 identifies the percent and actual area occupancy of the soil classes used in this study. This figure shows that class 3 (sand and/or gravel with silts and clays) and class 4 (lean clay) together occupy almost 70 percent of the data base countries. Only 5.5 percent of the total area of the countries mapped is characterized by rock outcrops and organic soil and peat occupy about 4 percent of the total area.

Figure A6 presents the area occupancy of rock within 20 feet of the surface. This rock can be exploited as a construction material, assuming that the rock thickness is three times the overburden thickness and that all hardness categories are acceptable. The three categories of major rock types are believed to be sufficient at this time. A more detailed breakout of rock types can be extracted when desired.

To get a more complete picture of sources of construction material map units 1, 2, and 3 (sand and/or gravels with or without silts and clays) that have thicknesses, > 20 feet should be included. From Figure A6 only 28 percent or 340,138 square kilometres of the priority one countries have soils deeper than 20 feet, and map units 1, 2, and 3 occupy 15 percent or 182,644 square kilometres of this area. These statistics indicate a relative abundance of construction materials.

CONCLUSIONS

Eleven countries were mapped to determine the occurrence of subgrade soils and establish the types of construction material available. These countries occur within three broad regions: Europe, Near East, and Far East and were selected on strategic importance and not necessarily on representativeness of terrain conditions with the three regions.

The inclusion of the second priority countries would have added to the data base and improved the validity of terrain in the three regions.

The factors mapped were soil type, rock type, and rock hardness, which were considered adequate to meet the objective of the study.

Small-scale mapping was required for this study which gives a generalization of terrain conditions. Large-scale mapping should be used for specific areas of interest within a region or country.

FIRST PRIORITY	SECOND PRIORITY
Europe	
West Germany Italy England Scotland Wales	Spain France Benelux
Middle East	
Israel Jordan Syria Lebanon	Iraq Saudi Arabia
Far East	
Taiwan South Korea	Thailand Viet Nam Laos Cambodia North Korea

Figure A-1. Data Base Countries and Priorities

Map Unit	USCS Symbol	Description or Class
1	GW, GP	Well-graded gravels, gravel-sand mixtures, little or no fines. Poorly-graded gravels, gravel-sand mixtures, little or no fines.
2	SW, SP	Well-graded sands, gravelly sands, little or no fines. Poorly-graded sands, gravelly sands, little or no fines.
3	GM, GC, SM, SC	Silty gravels, gravel-sand-clay mixtures. Clayey gravels, gravel-sand-clay mixtures. Silty sands, sand-silt mixtures. Clayey sands, sand-clay mixtures.
4	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
5	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight pasticity.
6	CH	Inorganic clays of high plasticity, fat clays.
7	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
8	OL, OH, Pt	Organic silts and organic silty clays of low plasticity. Organic clays of medium to high plasticity, organic silts. Peat and other highly organic soils.
9		Rock
W		Water

Figure A-2. Soil Classification

LEGEND

Map Unit	
▱ 1	Igneous undifferentiated
▱ 2	Intrusive (granite, gabbro, diorite, etc.)
▱ 3	Extrusive (basalt, andesite, rhyolite, felsitic)
▱ 4	Metamorphic undifferentiated
▱ 5	Gneiss
▱ 6	Schist
▱ 7	Slate
▱ 8	Quartzite
▱ 9	Sedimentary undifferentiated
▱ 10	Limestone
▱ 11	Sandstone
▱ 12	Shale
▱ 13	Rock 20 feet below surface

CHARACTERISTICS

1 Hard
2 Soft
3 Mixed
4 Absent

Figure A-3. Rock Types

LEGEND

* MAP UNIT	SOIL TYPE	ROCK TYPE	ROCK HRDNS	* MAP UNIT	SOIL TYPE	ROCK TYPE	ROCK HRDNS	* MAP UNIT	SOIL TYPE	ROCK TYPE	ROCK HRDNS	* MAP UNIT	SOIL TYPE	ROCK TYPE	ROCK HRDNS
1	1	2	1	35	3	4	1	69	4	11	3	103	7	7	3
2	1	3	1	36	3	4	3	70	4	12	2	104	7	9	2
3	1	4	1	37	3	5	1	71	4	13	4	105	7	9	3
4	1	7	3	38	3	6	3	73	5	2	1	106	7	10	1
5	1	8	1	39	3	7	3	73	5	3	1	107	7	13	4
6	1	9	2	40	3	8	1	74	5	3	2	108	8	2	1
7	1	9	3	41	3	9	1	75	5	5	1	109	8	3	1
8	1	10	1	42	3	9	2	76	5	7	3	110	8	5	1
9	1	10	2	43	3	9	3	77	5	9	1	111	8	6	3
10	1	10	3	44	3	10	1	78	5	9	2	112	8	7	3
11	1	11	2	45	3	10	2	79	5	9	3	113	8	8	1
12	1	11	3	46	3	10	3	80	5	10	1	114	8	9	2
13	1	12	2	47	3	11	2	81	5	10	2	115	8	10	1
14	1	13	4	48	3	11	3	82	5	10	3	116	8	10	2
15	2	2	1	49	3	12	2	83	5	11	2	117	8	11	2
16	2	3	1	50	3	13	4	84	5	11	3	118	8	11	3
17	2	4	1	51	4	2	1	85	5	12	2	119	8	12	2
18	2	5	1	52	4	3	1	86	5	13	4	120	8	13	4
19	2	7	3	53	4	3	2	87	6	2	1	121	9	2	1
20	2	8	1	54	4	3	3	88	6	3	1	122	9	3	1
21	2	9	2	55	4	3	4	89	6	3	2	123	9	3	2
22	2	9	3	56	4	4	1	90	6	4	3	124	9	4	1
23	2	10	1	57	4	4	3	91	6	5	1	125	9	7	3
24	2	10	2	58	4	5	1	92	6	9	1	126	9	8	1
25	2	10	3	59	4	6	3	93	6	9	2	127	9	9	1
26	2	11	2	60	4	7	3	94	6	9	3	128	9	9	2
27	2	11	3	61	4	8	1	95	6	10	1	129	9	9	3
28	2	12	2	62	4	9	1	96	6	10	2	130	9	10	1
29	2	13	4	63	4	9	2	97	6	10	3	131	9	10	3
30	3	2	1	64	4	9	3	98	6	11	2	132	9	11	3
31	3	3	1	65	4	10	1	99	6	11	3	133	9	12	2
32	3	3	2	66	4	10	2	100	6	12	2	134	9	13	4
33	3	3	3	67	4	10	3	101	6	13	4				
34	3	3	4	68	4	11	2	102	7	3	1				

* Each map unit represents a combination of numbers indicating the mapping classes of soil type, rock type, and rock hardness. The mapping class ranges of each factor are show below.

NOTE: Soil/rock complexes are mapped where no areally predominant (> 50 percent) soil or rock types occur. In such instances, the sequence is in descending order of percentage.

SOIL TYPES

Map Unit	USCS Symbol(s)	Description
1	GW, GP	Well- or poorly-graded gravels, gravel-sand mixtures, little or no fines.
2	SW, SP	Well- or poorly-graded sand, gravelly sands, little or no fines.
3	GM, GC, SM, SC	Silty or clayey gravels, gravel-sand-clay mixtures. Silty or clayey sands, sand-silt mixtures.
4	CL	Inorganic clays of low to medium plasticity, gravelly, sandy, or silty clays, lean clays.
5	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
6	CH	Inorganic clays of high plasticity.
7	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils.
8	OL, OH, Pt	Organic silts and silty clays and peat.
9	--	Rock
10	--	Water

ROCK TYPES

Map Unit	Description
1	Igneous undifferentiated
2	Intrusive (granite, gabbro, diorite, etc.)
3	Extrusive (basalt, andesite, rhyolite, felsitic)
4	Metamorphic undifferentiated
5	Gneiss
6	Schist
7	Slate
8	Quartzite
9	Sedimentary undifferentiated
10	Limestone
11	Sandstone
12	Shale
13	Rock > 20 ft below surface

ROCK CHARACTERISTICS

Map Unit	Description
1	Hard
2	Soft
3	Mixed
4	Absent

Figure A4. Master Legend for Factor Complex Maps

Soil Type	Percent Area Occupancy	Area Occupancy, km^2
GW, GP	4.642	55,109
SW, SP	9.608	114,071
GM,GC, SM, SC	37.082	440,249
CL	32.275	383,180
ML	4.664	55,377
CH	1.833	21,759
MH	0.264	3,126
OL, OH, Pt	4.116	48,866
Rock	5.516	65,492

Figure A-5. Area Occupancy of Soil Types in Data Base Countries

Occurrence of Rock*

Rock Type	Percent of Area	Area Occupancy, km^2
Igneous	11.584	137,530
Metamorphic	10.843	128,733
Sedimentary	48.923	580,828
Absent	28,650	340,138**

* Within 20 feet of the surface

** GW, GP, SW, SP, GM, GC, SM, SC occupy 182,644 square kilometres of this area

Figure A-6. Occurrence of Rock in Data Base Countries

TABLE A-1. DISTRIBUTION OF FACTOR COMPLEXES BY COUNTRIES

MAP	FACT	--TOTALS--		- FREQUENCY DISTRIBUTION BY COUNTRY - >																	
UNIT	CMPX	NOP	AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA	NOP	--AREA
1	1021	11	222	0	0	0	0	2	138	0	0	0	0	0	0	2	77	7	7	0	0
2	1031	44	7538	0	0	0	0	41	7428	0	0	0	0	0	0	1	104	2	6	0	0
3	1041	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
4	1073	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	0	0
5	1081	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0
6	1092	9	971	0	0	0	0	0	0	0	0	0	0	0	0	6	963	3	8	0	0
7	1093	8	6604	0	0	0	0	8	6604	0	0	0	0	0	0	0	0	0	0	0	0
8	1101	53	3386	0	0	0	0	45	3120	0	0	0	0	0	0	6	262	2	4	0	0
9	1102	4	212	0	0	0	0	0	0	0	0	0	0	0	0	4	212	0	0	0	0
10	1103	45	22790	0	0	0	0	45	22790	0	0	0	0	0	0	0	0	0	0	0	0
11	1112	4	179	0	0	0	0	0	0	0	0	0	0	0	0	4	179	0	0	0	0
12	1113	11	1008	0	0	0	0	2	29	0	0	0	0	0	0	9	979	0	0	0	0
13	1122	16	1668	0	0	0	0	0	0	0	0	0	0	0	0	16	1668	0	0	0	0
14	1134	92	10521	0	0	0	0	34	6096	0	0	0	0	0	0	29	4127	29	298	0	0
15	2021	33	4479	0	0	7	52	2	46	0	0	23	4380	0	0	0	0	1	1	0	0
16	2031	81	7806	0	0	0	0	34	2467	0	0	44	5211	0	0	1	104	2	24	0	0
17	2041	7	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	17	0	0
18	2051	16	4742	0	0	0	0	0	0	0	0	14	4665	0	0	2	77	0	0	0	0
19	2073	18	11192	0	0	0	0	0	0	0	0	18	11192	0	0	0	0	0	0	0	0
20	2081	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0
21	2092	92	11109	10	117	0	0	0	0	0	0	73	10006	0	0	6	963	3	23	0	0
22	2093	12	2231	0	0	0	0	8	2211	0	0	0	0	0	0	0	0	4	20	0	0
23	2101	95	16523	8	97	0	0	45	1038	3	21	31	15089	0	0	6	262	2	16	0	0
24	2102	4	212	0	0	0	0	0	0	0	0	0	0	0	0	4	212	0	0	0	0
25	2103	37	7742	0	0	1	11	36	7731	0	0	0	0	0	0	0	0	0	0	0	0
26	2112	22	243	18	64	0	0	0	0	0	0	0	0	0	0	4	179	0	0	0	0
27	2113	84	28765	1	1	33	10571	1	7	0	0	40	17207	0	0	9	979	0	0	0	0
28	2122	16	1668	0	0	0	0	0	0	0	0	0	0	0	0	16	1668	0	0	0	0
29	2134	139	17339	14	640	6	1239	13	39	6	81	41	10005	0	0	29	4127	30	1208	0	0
30	3021	162	33364	5	20	16	1129	2	92	0	0	0	0	59	8743	7	854	4	16	69	22510
31	3031	196	23070	6	6	30	10523	54	5195	0	0	0	0	20	2438	25	1352	0	0	61	3556
32	3032	9	939	0	0	0	0	0	0	0	0	0	0	9	939	0	0	0	0	0	0
33	3033	55	5325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	5325
34	3034	1	43	0	0	0	0	1	43	0	0	0	0	0	0	0	0	0	0	0	0
35	3041	70	27531	0	0	0	0	0	0	0	0	0	0	70	27531	0	0	0	0	0	0
36	3043	54	9262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	9262
37	3051	111	27713	0	0	0	0	0	0	0	0	1	19	0	0	41	5245	0	0	69	22449
38	3063	5	505	0	0	0	0	0	0	0	0	0	0	0	0	5	505	0	0	0	0
39	3073	41	3269	0	0	0	0	0	0	0	0	1	10	0	0	32	3223	8	36	0	0
40	3081	25	869	0	0	0	0	0	0	0	0	0	0	0	0	24	866	1	3	0	0
41	3091	85	13601	0	0	0	0	0	0	0	0	0	0	85	13601	0	0	0	0	0	0
42	3092	116	9676	29	1039	0	0	0	0	0	0	4	106	48	4489	19	4004	16	38	0	0
43	3093	205	55372	0	0	0	0	13	5024	13	657	0	0	122	33867	0	0	1	6	56	15818
44	3101	147	11278	17	1226	0	0	47	2096	25	498	3	60	0	0	49	4522	1	4	5	2872
45	3102	22	3934	0	0	0	0	0	0	0	0	0	0	7	384	15	3550	0	0	0	0
46	3103	120	24346	0	0	53	6341	67	18005	0	0	0	0	0	0	0	0	0	0	0	0
47	3112	42	1239	33	349	0	0	0	0	0	0	0	0	0	0	9	890	0	0	0	0
48	3113	115	27406	0	0	40	1963	28	10076	0	0	1	7	0	0	46	15360	0	0	0	0

TABLE A-1. DISTRIBUTION OF FACTOR COMPLEXES BY COUNTRIES (CONTINUED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	- FREQUENCY DISTRIBUTION BY COUNTRY - > NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA
49	3122	66	6723	0	0	0	0	0	0	0	0	0	0	30	2370	36	4353	0	0	0	0
50	3134	438	154784	18	742	44	2414	39	8869	0	0	48	66985	132	43542	36	23279	54	3203	67	5794
51	4021	115	11406	0	0	6	78	2	46	0	0	10	1479	7	1787	50	7251	16	451	24	314
52	4031	228	12835	14	188	48	1369	57	2800	7	250	30	1765	7	1112	35	2314	5	120	25	2917
53	4032	12	956	0	0	0	0	0	0	0	0	0	0	12	956	0	0	0	0	0	0
54	4033	8	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	64
55	4034	1	28	0	0	0	0	1	28	0	0	0	0	0	0	0	0	0	0	0	0
56	4041	50	3433	0	0	0	0	0	0	0	0	0	0	17	1293	0	0	33	2140	0	0
57	4043	20	2194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	2194
58	4051	43	1898	0	0	0	0	0	0	0	0	8	948	0	0	11	636	0	0	24	314
59	4063	38	4610	0	0	0	0	0	0	0	0	0	0	0	0	38	4610	0	0	0	0
60	4073	47	7561	0	0	0	0	0	0	0	0	21	5009	0	0	9	1240	17	1312	0	0
61	4081	40	2747	0	0	0	0	0	0	0	0	0	0	0	0	26	1180	14	1567	0	0
62	4091	26	1795	0	0	0	0	0	0	0	0	0	0	26	1795	0	0	0	0	0	0
63	4092	177	43597	21	1114	0	0	0	0	0	0	57	25058	56	11812	13	783	30	4830	0	0
64	4093	153	22536	0	0	0	0	17	3434	22	331	0	0	77	12954	0	0	29	5635	8	182
65	4101	221	16822	32	812	0	0	47	1046	13	5042	34	2730	0	0	69	6530	23	558	3	104
66	4102	54	12383	0	0	0	0	0	0	18	800	0	0	21	7180	15	4403	0	0	0	0
67	4103	119	64279	0	0	52	54141	67	10138	0	0	0	0	0	0	0	0	0	0	0	0
68	4112	39	2087	28	143	0	0	0	0	0	0	0	0	0	0	11	1944	0	0	0	0
69	4113	191	38565	0	0	32	868	33	7128	0	0	44	12222	0	0	82	18347	0	0	0	0
70	4122	93	30245	0	0	0	0	0	0	17	798	0	0	31	20441	45	9006	0	0	0	0
71	4134	407	103139	35	888	57	3397	38	8284	10	1590	21	8849	100	53250	49	21766	97	5135	0	0
72	5021	3	116	0	0	0	0	0	0	0	0	2	52	1	64	0	0	0	0	0	0
73	5031	49	6492	0	0	0	0	7	446	0	0	16	682	19	5117	7	247	0	0	0	0
74	5032	14	7931	0	0	0	0	0	0	0	0	0	0	14	7931	0	0	0	0	0	0
75	5051	7	172	0	0	0	0	0	0	0	0	2	77	0	0	5	95	0	0	0	0
76	5073	21	862	0	0	0	0	0	0	0	0	19	807	0	0	2	55	0	0	0	0
77	5091	1	22	0	0	0	0	0	0	0	0	0	0	1	22	0	0	0	0	0	0
78	5092	75	6697	0	0	0	0	0	0	0	0	73	6610	2	87	0	0	0	0	0	0
79	5093	16	1435	0	0	0	0	7	926	0	0	0	0	9	519	0	0	0	0	0	0
80	5101	48	1983	0	0	0	0	2	225	0	0	31	1075	0	0	15	683	0	0	0	0
81	5102	1	21	0	0	0	0	0	0	0	0	0	0	0	0	1	21	0	0	0	0
82	5103	26	3235	0	0	3	647	23	2588	0	0	0	0	0	0	0	0	0	0	0	0
83	5112	5	877	0	0	0	0	0	0	0	0	0	0	0	0	5	877	0	0	0	0
84	5113	61	4823	0	0	0	0	3	422	0	0	42	1375	0	0	16	3036	0	0	0	0
85	5122	9	3116	0	0	0	0	0	0	0	0	0	0	0	0	9	3116	0	0	0	0
86	5134	99	17595	0	0	2	539	8	180	0	0	73	15854	12	838	4	184	0	0	0	0
87	6021	2	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12
88	6031	3	93	0	0	2	79	0	0	0	0	0	0	1	14	0	0	0	0	0	0
89	6032	1	22	0	0	0	0	0	0	0	0	0	0	1	22	0	0	0	0	0	0
90	6043	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8
91	6051	2	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12
92	6091	3	78	0	0	0	0	0	0	0	0	0	0	3	78	0	0	0	0	0	0
93	6092	13	764	6	18	0	0	0	0	0	0	0	0	2	35	5	711	0	0	0	0
94	6093	10	149	0	0	0	0	0	0	0	0	0	0	10	149	0	0	0	0	0	0
95	6101	8	168	5	8	0	0	0	0	0	0	0	0	0	0	3	160	0	0	0	0
96	6102	4	501	0	0	0	0	0	0	0	0	0	0	0	0	4	501	0	0	0	0

TABLE A-1. DISTRIBUTION OF FACTOR COMPLEXES BY COUNTRIES (CONCLUDED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	- FREQUENCY DISTRIBUTION BY COUNTRY - > NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA	NOP	AREA
97	6103	6	699	0	0	6	699	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	6112	5	13	5	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	6113	1	19	0	0	1	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	6122	8	2272	0	0	0	0	0	0	0	0	0	0	2	33	6	2239	0	0	0	0
101	6134	61	16949	7	200	0	0	0	0	0	0	0	0	25	10835	3	1157	3	1109	23	3648
102	7031	8	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	120	0	0
103	7073	3	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	0	0
104	7092	30	1230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	1230	0	0
105	7093	3	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	25	0	0
106	7101	4	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	28	0	0
107	7134	40	1709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	1709	0	0
108	8021	11	2547	0	0	0	0	0	0	0	0	0	0	0	0	11	2547	0	0	0	0
109	8031	24	1236	1	3	0	0	0	0	0	0	0	0	0	0	23	1233	0	0	0	0
110	8051	40	5231	0	0	0	0	0	0	0	0	0	0	0	0	40	5231	0	0	0	0
111	8063	5	1554	0	0	0	0	0	0	0	0	0	0	0	0	5	1554	0	0	0	0
112	8073	31	3305	0	0	0	0	0	0	0	0	0	0	0	0	31	3305	0	0	0	0
113	8081	25	882	0	0	0	0	0	0	0	0	0	0	0	0	25	882	0	0	0	0
114	8092	6	179	0	0	0	0	0	0	0	0	0	0	0	0	6	179	0	0	0	0
115	8101	34	2803	0	0	0	0	0	0	0	0	0	0	0	0	34	2803	0	0	0	0
116	8102	8	2925	0	0	0	0	0	0	0	0	0	0	0	0	8	2925	0	0	0	0
117	8112	6	197	2	2	0	0	0	0	0	0	0	0	0	0	4	195	0	0	0	0
118	8113	44	9898	0	0	0	0	0	0	0	0	0	0	0	0	44	9898	0	0	0	0
119	8122	18	754	0	0	0	0	0	0	0	0	0	0	0	0	18	754	0	0	0	0
120	8134	167	17355	7	29	0	0	0	0	0	0	123	10510	0	0	37	6816	0	0	0	0
121	9021	66	2750	0	0	0	0	2	138	0	0	0	0	50	2063	0	0	14	549	0	0
122	9031	48	7965	0	0	0	0	34	7409	0	0	0	0	13	505	0	0	1	51	0	0
123	9032	6	171	0	0	0	0	0	0	0	0	0	0	6	171	0	0	0	0	0	0
124	9041	58	6614	0	0	0	0	0	0	0	0	0	0	57	6606	0	0	1	8	0	0
125	9073	5	2098	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2098	0	0
126	9081	5	425	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	425	0	0
127	9091	62	2827	0	0	0	0	0	0	0	0	0	0	62	2827	0	0	0	0	0	0
128	9092	33	1096	0	0	0	0	0	0	0	0	0	0	27	799	0	0	6	297	0	0
129	9093	100	14530	0	0	0	0	8	6604	0	0	0	0	92	7926	0	0	0	0	0	0
130	9101	53	3303	0	0	0	0	45	3120	0	0	0	0	0	0	0	0	8	183	0	0
131	9103	34	22500	0	0	0	0	34	22500	0	0	0	0	0	0	0	0	0	0	0	0
132	9113	1	21	0	0	0	0	1	21	0	0	0	0	0	0	0	0	0	0	0	0
133	9122	23	445	0	0	0	0	0	0	0	0	0	0	23	445	0	0	0	0	0	0
134	9134	65	747	0	0	0	0	13	118	0	0	0	0	51	628	0	0	1	1	0	0

TABLE A-2. FREQUENCY OF OCCURRENCE AND AREA OCCUPANCY
SORTED SEQUENTIALLY BY MAP UNIT

MAP	FACT	--TOTALS--		--NOP PERCENTS--		::	--AREA PERCENTS--	
UNIT	CMPX	NOP	AREA	OCPY	ACUM	::	OCPY	ACUM
1	1021	11	222	0.1628	0.1628	::	0.0187	0.0187
2	1031	44	7538	0.6512	0.8140	::	0.6349	0.6536
3	1041	1	1	0.0148	0.8288	::	0.0001	0.6537
4	1073	4	5	0.0592	0.8880	::	0.0004	0.6541
5	1081	2	4	0.0296	0.9176	::	0.0003	0.6545
6	1092	9	971	0.1332	1.0508	::	0.0818	0.7363
7	1093	8	6604	0.1184	1.1692	::	0.5564	1.2925
8	1101	53	3386	0.7844	1.9535	::	0.2852	1.5777
9	1102	4	212	0.0592	2.0127	::	0.0179	1.5956
10	1103	45	22790	0.6660	2.6787	::	1.9196	3.5152
11	1112	4	179	0.0592	2.7379	::	0.0151	3.5302
12	1113	11	1008	0.1628	2.9007	::	0.0849	3.6151
13	1122	16	1668	0.2368	3.1375	::	0.1405	3.7556
14	1134	92	10521	1.3616	4.4990	::	0.8862	4.6418
15	2021	33	4479	0.4884	4.9874	::	0.3773	5.0191
16	2031	81	7806	1.1988	6.1862	::	0.6575	5.6766
17	2041	7	17	0.1036	6.2898	::	0.0014	5.6780
18	2051	16	4742	0.2368	6.5266	::	0.3994	6.0774
19	2073	18	11192	0.2664	6.7930	::	0.9427	7.0201
20	2081	1	3	0.0148	6.8078	::	0.0003	7.0204
21	2092	92	11109	1.3616	8.1693	::	0.9357	7.9561
22	2093	12	2231	0.1776	8.3469	::	0.1879	8.1440
23	2101	95	16523	1.4059	9.7528	::	1.3917	9.5357
24	2102	4	212	0.0592	9.8120	::	0.0179	9.5536
25	2103	37	7742	0.5476	10.3596	::	0.6521	10.2057
26	2112	22	243	0.3256	10.6852	::	0.0205	10.2262
27	2113	84	28765	1.2432	11.9284	::	2.4829	12.6490
28	2122	16	1668	0.2368	12.1652	::	0.1405	12.7895
29	2134	139	17339	2.0571	14.2223	::	1.4605	14.2500
30	3021	162	33364	2.3975	16.6198	::	2.8102	17.0602
31	3031	196	23070	2.9007	19.5205	::	1.9432	19.0034
32	3032	9	939	0.1332	19.6537	::	0.0791	19.0825
33	3033	55	5325	0.8140	20.4677	::	0.4485	19.5310
34	3034	1	43	0.0148	20.4825	::	0.0036	19.5346
35	3041	70	27531	1.0360	21.5184	::	2.3189	21.8536
36	3043	54	9262	0.7992	22.3176	::	0.7801	22.6337
37	3051	111	27713	1.6427	23.9603	::	2.3343	24.9680
38	3063	5	505	0.0740	24.0343	::	0.0425	25.0105
39	3073	41	3269	0.6068	24.6411	::	0.2754	25.2859
40	3081	25	869	0.3700	25.0111	::	0.0732	25.3591
41	3091	85	13601	1.2580	26.2691	::	1.1456	26.5047
42	3092	116	9676	1.7167	27.9858	::	0.8150	27.3197
43	3093	205	55372	3.0339	31.0197	::	4.6640	31.9836
44	3101	147	11278	2.1755	33.1952	::	0.9499	32.9336
45	3102	22	3934	0.3256	33.5208	::	0.3313	33.2649

TABLE A-2. FREQUENCY OF OCCURRENCE AND AREA OCCUPANCY SORTED SEQUENTIALLY BY MAP UNIT (CONTINUED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
46	3103	120	24346	1.7759	35.2967	::	2.0507	35.3156
47	3112	42	1239	0.6216	35.9183	::	0.1044	35.4200
48	3113	115	27406	1.7019	37.6202	::	2.3084	37.7284
49	3122	66	6723	0.9768	38.5970	::	0.5663	38.2946
50	3134	438	154784	6.4822	45.0792	::	13.0374	51.3321
51	4021	115	11406	1.7019	46.7811	::	0.9607	52.2928
52	4031	228	12835	3.3743	50.1554	::	1.0811	53.3739
53	4032	12	956	0.1776	50.3330	::	0.0805	53.4544
54	4033	8	64	0.1184	50.4514	::	0.0054	53.4598
55	4034	1	28	0.0148	50.4662	::	0.0024	53.4621
56	4041	50	3433	0.7400	51.2062	::	0.2892	53.7513
57	4043	20	2194	0.2960	51.5021	::	0.1848	53.9361
58	4051	43	1898	0.6364	52.1385	::	0.1599	54.0960
59	4063	38	4610	0.5624	52.7009	::	0.3883	54.4843
60	4073	47	7561	0.6956	53.3965	::	0.6369	55.1211
61	4081	40	2747	0.5920	53.9885	::	0.2314	55.3525
62	4091	26	1795	0.3848	54.3733	::	0.1512	55.5037
63	4092	177	43597	2.6195	56.9927	::	3.6722	59.1759
64	4093	153	22536	2.2643	59.2571	::	1.8982	61.0741
65	4101	221	16822	3.2707	62.5278	::	1.4169	62.4910
66	4102	54	12383	0.7992	63.3269	::	1.0430	63.5340
67	4103	119	64279	1.7611	65.0881	::	5.4142	68.9482
68	4112	39	2087	0.5772	65.6652	::	0.1758	69.1240
69	4113	191	38565	2.8267	68.4919	::	3.2483	72.3723
70	4122	93	30245	1.3764	69.8683	::	2.5475	74.9198
71	4134	407	103139	6.0234	75.8917	::	8.6874	83.6072
72	5021	3	116	0.0444	75.9361	::	0.0098	83.6170
73	5031	49	6492	0.7252	76.6612	::	0.5468	84.1638
74	5032	14	7931	0.2072	76.8684	::	0.6680	84.8318
75	5051	7	172	0.1036	76.9720	::	0.0145	84.8463
76	5073	21	862	0.3108	77.2828	::	0.0726	84.9189
77	5091	1	22	0.0148	77.2976	::	0.0019	84.9208
78	5092	75	6697	1.1100	78.4076	::	0.5641	85.4849
79	5093	16	1435	0.2368	78.6444	::	0.1209	85.6057
80	5101	48	1983	0.7104	79.3547	::	0.1670	85.7728
81	5102	1	21	0.0148	79.3695	::	0.0018	85.7745
82	5103	26	3235	0.3848	79.7543	::	0.2725	86.0470
83	5112	5	877	0.0740	79.8283	::	0.0739	86.1209
84	5113	61	4823	0.9028	80.7311	::	0.4062	86.5271
85	5122	9	3116	0.1332	80.8643	::	0.2625	86.7896
86	5134	99	17595	1.4651	82.3294	::	1.4820	88.2716
87	6021	2	12	0.0296	82.3590	::	0.0010	88.2726
88	6031	3	93	0.0444	82.4034	::	0.0078	88.2804
89	6032	1	22	0.0148	82.4182	::	0.0019	88.2823
90	6043	1	8	0.0148	82.4330	::	0.0007	88.2830

TABLE A-2. FREQUENCY OF OCCURRENCE AND AREA OCCUPANCY SORTED SEQUENTIALLY BY MAP UNIT (CONCLUDED)

MAP UNIT	FACT CMPX	--TOTALS-- NOF	AREA	--NOR PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
91	6051	2	12	0.0296	82.4626	::	0.0010	88.2840
92	6091	3	78	0.0444	82.5070	::	0.0066	88.2906
93	6092	13	764	0.1924	82.6994	::	0.0643	88.3549
94	6093	10	149	0.1480	82.8474	::	0.0126	88.3675
95	6101	8	168	0.1184	82.9658	::	0.0142	88.3816
96	6102	4	501	0.0592	83.0250	::	0.0422	88.4238
97	6103	6	699	0.0888	83.1138	::	0.0589	88.4827
98	6112	5	13	0.0740	83.1878	::	0.0011	88.4838
99	6113	1	19	0.0148	83.2026	::	0.0016	88.4854
100	6122	8	2272	0.1184	83.3210	::	0.1913	88.6767
101	6134	61	16949	0.9028	84.2238	::	1.4276	90.1044
102	7031	8	120	0.1184	84.3422	::	0.0101	90.1145
103	7073	3	14	0.0444	84.3866	::	0.0012	90.1156
104	7092	30	1230	0.4440	84.8305	::	0.1036	90.2192
105	7093	3	25	0.0444	84.8749	::	0.0021	90.2213
106	7101	4	28	0.0592	84.9341	::	0.0024	90.2237
107	7134	40	1709	0.5920	85.5261	::	0.1439	90.3677
108	8021	11	2547	0.1628	85.6889	::	0.2145	90.5822
109	8031	24	1236	0.3552	86.0441	::	0.1041	90.6863
110	8051	40	5231	0.5920	86.6361	::	0.4406	91.1269
111	8063	5	1554	0.0740	86.7101	::	0.1309	91.2578
112	8073	31	3305	0.4588	87.1689	::	0.2784	91.5362
113	8081	25	882	0.3700	87.5388	::	0.0743	91.6105
114	8092	6	179	0.0888	87.6276	::	0.0151	91.6255
115	8101	34	2803	0.5032	88.1308	::	0.2361	91.8616
116	8102	8	2925	0.1184	88.2492	::	0.2464	92.1080
117	8112	6	197	0.0888	88.3380	::	0.0166	92.1246
118	8113	44	9898	0.6512	88.9892	::	0.8337	92.9583
119	8122	18	754	0.2664	89.2556	::	0.0635	93.0218
120	8134	167	17355	2.4715	91.7271	::	1.4618	94.4836
121	9021	66	2750	0.9768	92.7039	::	0.2316	94.7153
122	9031	48	7965	0.7104	93.4142	::	0.6709	95.3861
123	9032	6	171	0.0888	93.5030	::	0.0144	95.4006
124	9041	58	6614	0.8584	94.3614	::	0.5571	95.9576
125	9073	5	2098	0.0740	94.4354	::	0.1767	96.1344
126	9081	5	425	0.0740	94.5094	::	0.0358	96.1702
127	9091	62	2827	0.9176	95.4270	::	0.2381	96.4083
128	9092	33	1096	0.4884	95.9153	::	0.0923	96.5006
129	9093	100	14530	1.4799	97.3953	::	1.2239	97.7245
130	9101	53	3303	0.7844	98.1797	::	0.2782	98.0027
131	9103	34	22500	0.5032	98.6828	::	1.8952	99.8978
132	9113	1	21	0.0148	98.6976	::	0.0019	99.8996
133	9122	23	445	0.3404	99.0380	::	0.0375	99.9371
134	9134	65	747	0.9620	100.0000	::	0.0629	100.0000

TABLE A-3. FREQUENCY OF OCCURRENCE OF FACTOR COMPLEXES SORTED FROM MINIMUM TO MAXIMUM NUMBER OF PATCHES

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
3	1041	1	1	0.0148	0.0148	::	0.0001	0.0001
20	2081	1	3	0.0148	0.0296	::	0.0003	0.0003
34	3034	1	43	0.0148	0.0444	::	0.0037	0.0040
55	4034	1	28	0.0148	0.0592	::	0.0023	0.0063
77	5091	1	22	0.0148	0.0740	::	0.0019	0.0082
81	5102	1	21	0.0148	0.0888	::	0.0018	0.0099
89	6032	1	22	0.0148	0.1036	::	0.0019	0.0118
90	6043	1	8	0.0148	0.1184	::	0.0007	0.0125
99	6113	1	19	0.0148	0.1332	::	0.0016	0.0141
132	9113	1	21	0.0148	0.1480	::	0.0018	0.0158
5	1081	2	4	0.0296	0.1776	::	0.0003	0.0162
87	6021	2	12	0.0296	0.2072	::	0.0010	0.0172
91	6051	2	12	0.0296	0.2368	::	0.0010	0.0182
72	5021	3	116	0.0444	0.2812	::	0.0098	0.0280
88	6031	3	93	0.0444	0.3256	::	0.0078	0.0358
92	6091	3	78	0.0444	0.3700	::	0.0066	0.0424
103	7073	3	14	0.0444	0.4144	::	0.0012	0.0435
105	7093	3	25	0.0444	0.4588	::	0.0021	0.0457
4	1073	4	5	0.0592	0.5180	::	0.0004	0.0461
9	1102	4	212	0.0592	0.5772	::	0.0179	0.0639
11	1112	4	179	0.0592	0.6364	::	0.0151	0.0790
24	2102	4	212	0.0592	0.6956	::	0.0179	0.0969
96	6102	4	501	0.0592	0.7548	::	0.0422	0.1391
106	7101	4	28	0.0592	0.8140	::	0.0024	0.1414
38	3063	5	505	0.0740	0.8880	::	0.0427	0.1840
83	5112	5	877	0.0740	0.9620	::	0.0739	0.2578
98	6112	5	13	0.0740	1.0360	::	0.0011	0.2589
111	8063	5	1554	0.0740	1.1100	::	0.1309	0.3898
125	9073	5	2098	0.0740	1.1840	::	0.1767	0.5665
126	9081	5	425	0.0740	1.2580	::	0.0358	0.6023
97	6103	6	699	0.0888	1.3468	::	0.0589	0.6612
114	8092	6	179	0.0888	1.4355	::	0.0151	0.6763
117	8112	6	197	0.0888	1.5243	::	0.0166	0.6929
123	9032	6	171	0.0888	1.6131	::	0.0144	0.7073
17	2041	7	17	0.1036	1.7167	::	0.0014	0.7087
75	5051	7	172	0.1036	1.8203	::	0.0145	0.7232
7	1093	8	6604	0.1184	1.9387	::	0.5563	1.2794
54	4033	8	64	0.1184	2.0571	::	0.0054	1.2848
95	6101	8	168	0.1184	2.1755	::	0.0142	1.2990
100	6122	8	2272	0.1184	2.2939	::	0.1915	1.4904
102	7031	8	120	0.1184	2.4123	::	0.0101	1.5005
116	8102	8	2925	0.1184	2.5307	::	0.2463	1.7468
6	1092	9	971	0.1332	2.6639	::	0.0818	1.8286
32	3032	9	939	0.1332	2.7971	::	0.0791	1.9077
85	5122	9	3116	0.1332	2.9303	::	0.2625	2.1702

TABLE A-3. FREQUENCY OF OCCURRENCE OF FACTOR COMPLEXES SORTED FROM MINIMUM TO MAXIMUM NUMBER OF PATCHES (CONTINUED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
94	6093	10	149	0.1480	3.0783	::	0.0126	2.1827
1	1021	11	222	0.1628	3.2411	::	0.0187	2.2014
12	1113	11	1088	0.1628	3.4039	::	0.0849	2.2863
108	8021	11	2547	0.1628	3.5667	::	0.2146	2.5009
22	2093	12	2231	0.1776	3.7443	::	0.1879	2.6888
53	4032	12	956	0.1776	3.9219	::	0.0805	2.7693
93	6092	13	764	0.1924	4.1143	::	0.0644	2.8337
74	5032	14	7931	0.2072	4.3214	::	0.6680	3.5017
13	1122	16	1668	0.2368	4.5582	::	0.1405	3.6422
18	2051	16	4742	0.2368	4.7950	::	0.3994	4.0416
28	2122	16	1668	0.2368	5.0318	::	0.1405	4.1821
79	5093	16	1435	0.2368	5.2686	::	0.1209	4.3030
19	2073	18	11192	0.2664	5.5350	::	0.9427	5.2457
119	8122	18	754	0.2664	5.8014	::	0.0635	5.3092
57	4043	20	2194	0.2960	6.0974	::	0.1848	5.4940
76	5073	21	862	0.3108	6.4082	::	0.0726	5.5666
26	2112	22	243	0.3256	6.7338	::	0.0805	5.5870
45	3102	22	3934	0.3256	7.0593	::	0.3514	5.9184
133	9122	23	445	0.3404	7.3997	::	0.0375	5.9559
109	8031	24	1236	0.3552	7.7549	::	0.1041	6.0600
40	3081	25	869	0.3700	8.1249	::	0.0732	6.1332
113	8081	25	882	0.3700	8.4949	::	0.0743	6.2075
62	4091	26	1795	0.3848	8.8797	::	0.1512	6.3587
82	5103	26	3235	0.3848	9.2645	::	0.2725	6.6312
104	7092	30	1230	0.4440	9.7085	::	0.1036	6.7348
112	8073	31	3305	0.4588	10.1672	::	0.2783	7.0131
15	2021	33	4479	0.4884	10.6556	::	0.3773	7.3904
128	9092	33	1096	0.4884	11.1440	::	0.0923	7.4827
115	8101	34	2803	0.5032	11.6472	::	0.2361	7.7188
131	9103	34	22500	0.5032	12.1504	::	1.8952	9.6140
25	2103	37	7742	0.5476	12.6979	::	0.6521	10.2661
59	4063	38	4610	0.5624	13.2603	::	0.3883	10.6544
68	4112	39	2087	0.5772	13.8375	::	0.1758	10.8302
61	4081	40	2747	0.5920	14.4295	::	0.2314	11.0616
107	7134	40	1709	0.5920	15.0215	::	0.1439	11.2055
110	8051	40	5231	0.5920	15.6134	::	0.4406	11.6461
39	3073	41	3269	0.6068	16.2202	::	0.2754	11.9215
47	3112	42	1239	0.6216	16.8418	::	0.1043	12.0258
58	4051	43	1898	0.6364	17.4782	::	0.1599	12.1857
2	1031	44	7538	0.6512	18.1293	::	0.6349	12.8206
118	8113	44	9898	0.6512	18.7805	::	0.8337	13.6543
10	1103	45	22790	0.6660	19.4465	::	1.9196	15.5739
60	4073	47	7561	0.6956	20.1421	::	0.6369	16.2108
80	5101	48	1983	0.7104	20.8524	::	0.1670	16.3778
122	9031	48	7965	0.7104	21.5628	::	0.6709	17.0487

TABLE A-3. FREQUENCY OF OCCURRENCE OF FACTOR COMPLEXES SORTED FROM MINIMUM TO MAXIMUM NUMBER OF PATCHES (CONCLUDED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
73	5031	49	6492	0.7252	22.2880	::	0.5469	17.5995
56	4041	50	3433	0.7400	23.0280	::	0.2892	17.8847
8	1101	53	3386	0.7844	23.8123	::	0.2852	18.1699
130	9101	53	3383	0.7844	24.5967	::	0.2782	18.4481
36	3043	54	9262	0.7992	25.3959	::	0.7801	19.2282
66	4102	54	12383	0.7992	26.1951	::	1.0439	20.2712
33	3033	55	5325	0.8140	27.0090	::	0.4489	20.7198
124	9041	58	6614	0.8584	27.8674	::	0.5571	21.2769
84	5113	61	4823	0.9028	28.7702	::	0.4862	21.6831
101	6134	61	16949	0.9028	29.6729	::	1.4879	23.1107
127	9091	62	2827	0.9176	30.5905	::	0.2381	23.3488
134	9134	65	747	0.9620	31.5525	::	0.0629	23.4117
49	3122	66	6723	0.9768	32.5292	::	0.5663	23.9780
121	9021	66	2750	0.9768	33.5060	::	0.2516	24.2097
35	3041	70	27531	1.0360	34.5420	::	2.3189	26.5286
78	5092	75	6697	1.1100	35.6519	::	0.5641	27.0927
16	2031	81	7806	1.1988	36.8507	::	0.6979	27.7502
27	2113	84	28765	1.2432	38.0938	::	2.4829	30.1730
41	3091	85	13601	1.2580	39.3518	::	1.1459	31.3186
14	1134	92	10521	1.3616	40.7133	::	0.8862	32.2048
21	2092	92	11109	1.3616	42.0749	::	0.9857	33.1405
70	4122	93	30245	1.3764	43.4512	::	2.5479	35.6881
23	2101	95	16523	1.4059	44.8572	::	1.3917	37.0798
86	5134	99	17595	1.4651	46.3223	::	1.4820	38.5618
129	9093	100	14530	1.4799	47.8023	::	1.2839	39.7857
37	3051	111	27713	1.6427	49.4450	::	2.3343	42.1199
48	3113	115	27486	1.7019	51.1470	::	2.3889	44.4283
51	4021	115	11486	1.7019	52.8489	::	0.9607	45.3891
42	3092	116	9676	1.7167	54.5656	::	0.8150	46.2041
67	4103	119	64279	1.7611	56.3268	::	5.4142	51.6183
46	3103	120	24346	1.7759	58.1027	::	2.0507	53.6689
29	2134	139	17339	2.0571	60.1598	::	1.4409	55.1294
44	3101	147	11278	2.1755	62.3354	::	0.9499	56.0793
64	4093	153	22536	2.2643	64.5997	::	1.8982	57.9775
30	3021	162	33364	2.3975	66.9972	::	2.8102	60.7878
120	8134	167	17355	2.4715	69.4687	::	1.4618	62.2496
63	4092	177	43597	2.6195	72.0882	::	3.6722	65.9217
69	4113	191	38565	2.8267	74.9149	::	3.2483	69.1701
31	3031	196	23070	2.9007	77.8156	::	1.9432	71.1132
43	3093	205	55372	3.0339	80.8495	::	4.6649	75.7772
65	4101	221	16882	3.2707	84.1202	::	1.4867	77.1941
52	4031	228	12835	3.3743	87.4945	::	1.0811	78.2752
71	4134	407	103139	6.0234	93.5178	::	8.6879	86.9626
50	3134	438	154784	6.4822	100.0000	::	13.0379	100.0000

TABLE A-4. FACTOR COMPLEXES SORTED FROM MINIMUM TO MAXIMUM AREA OCCUPANCY

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
3	1041	1	1	0.0148	0.0148	::	0.0001	0.0001
20	2081	1	3	0.0148	0.0296	::	0.0003	0.0003
5	1081	2	4	0.0296	0.0592	::	0.0004	0.0007
4	1073	4	5	0.0592	0.1184	::	0.0004	0.0011
90	6043	1	8	0.0148	0.1332	::	0.0007	0.0018
87	6021	2	12	0.0296	0.1628	::	0.0010	0.0028
91	6051	2	12	0.0296	0.1924	::	0.0010	0.0038
98	6112	5	13	0.0740	0.2664	::	0.0011	0.0049
103	7073	3	14	0.0444	0.3108	::	0.0012	0.0061
17	2041	7	17	0.1036	0.4144	::	0.0014	0.0075
99	6113	1	19	0.0148	0.4292	::	0.0016	0.0091
81	5102	1	21	0.0148	0.4440	::	0.0018	0.0109
132	9113	1	21	0.0148	0.4588	::	0.0018	0.0126
77	5091	1	22	0.0148	0.4736	::	0.0019	0.0145
89	6032	1	22	0.0148	0.4884	::	0.0019	0.0163
105	7093	3	25	0.0444	0.5328	::	0.0021	0.0184
55	4034	1	28	0.0148	0.5476	::	0.0024	0.0208
106	7101	4	28	0.0592	0.6068	::	0.0024	0.0232
34	3034	1	43	0.0148	0.6216	::	0.0036	0.0268
54	4033	8	64	0.1184	0.7400	::	0.0054	0.0322
92	6091	3	78	0.0444	0.7844	::	0.0066	0.0387
88	6031	3	93	0.0444	0.8288	::	0.0079	0.0466
72	5021	3	116	0.0444	0.8732	::	0.0098	0.0563
102	7031	8	120	0.1184	0.9916	::	0.0101	0.0665
94	6093	10	149	0.1480	1.1396	::	0.0126	0.0790
95	6101	8	168	0.1184	1.2580	::	0.0142	0.0932
123	9032	6	171	0.0888	1.3468	::	0.0144	0.1076
75	5051	7	172	0.1036	1.4503	::	0.0144	0.1220
11	1112	4	179	0.0592	1.5095	::	0.0151	0.1371
114	8092	6	179	0.0888	1.5983	::	0.0151	0.1522
117	8112	6	197	0.0888	1.6871	::	0.0166	0.1688
9	1102	4	212	0.0592	1.7463	::	0.0179	0.1867
24	2102	4	212	0.0592	1.8055	::	0.0179	0.2045
1	1021	11	222	0.1628	1.9683	::	0.0187	0.2232
26	2112	22	243	0.3256	2.2939	::	0.0205	0.2437
126	9081	5	425	0.0740	2.3679	::	0.0358	0.2795
133	9122	23	445	0.3404	2.7083	::	0.0375	0.3170
96	6102	4	501	0.0592	2.7675	::	0.0422	0.3592
38	3063	5	505	0.0740	2.8415	::	0.0425	0.4017
97	6103	6	699	0.0888	2.9303	::	0.0589	0.4606
134	9134	65	747	0.9620	3.8923	::	0.0629	0.5235
119	8122	18	754	0.2664	4.1587	::	0.0635	0.5870
93	6092	13	764	0.1924	4.3510	::	0.0643	0.6513
76	5073	21	862	0.3108	4.6618	::	0.0726	0.7240
40	3081	25	869	0.3700	5.0318	::	0.0732	0.7972

TABLE A-4. FACTOR COMPLEXES SORTED FROM MINIMUM TO MAXIMUM AREA OCCUPANCY (CONTINUED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
83	5112	5	877	0.0740	5.1058	::	0.0739	0.8710
113	8081	25	882	0.3700	5.4758	::	0.0743	0.9453
32	3032	9	939	0.1332	5.6090	::	0.0791	1.0244
53	4032	12	956	0.1776	5.7866	::	0.0805	1.1049
6	1092	9	971	0.1332	5.9198	::	0.0818	1.1867
12	1113	11	1008	0.1628	6.0826	::	0.0849	1.2716
128	9092	33	1096	0.4884	6.5710	::	0.0923	1.3639
104	7092	30	1230	0.4440	7.0149	::	0.1036	1.4675
109	8031	24	1236	0.3552	7.3701	::	0.1041	1.5716
47	3112	42	1239	0.6216	7.9917	::	0.1044	1.6760
79	5093	16	1435	0.2368	8.2285	::	0.1209	1.7969
111	8063	5	1554	0.0740	8.3025	::	0.1309	1.9278
13	1122	16	1668	0.2368	8.5393	::	0.1405	2.0683
28	2122	16	1668	0.2368	8.7761	::	0.1405	2.2088
107	7134	40	1709	0.5920	9.3681	::	0.1439	2.3527
62	4091	26	1795	0.3848	9.7529	::	0.1512	2.5039
58	4051	43	1898	0.6364	10.3892	::	0.1599	2.6638
80	5101	48	1983	0.7104	11.0996	::	0.1670	2.8308
68	4112	39	2087	0.5772	11.6768	::	0.1758	3.0066
125	9073	5	2098	0.0740	11.7508	::	0.1767	3.1833
57	4043	20	2194	0.2960	12.0468	::	0.1848	3.3681
22	2093	12	2231	0.1776	12.2244	::	0.1879	3.5560
100	6122	8	2272	0.1184	12.3428	::	0.1914	3.7474
108	8021	11	2547	0.1628	12.5056	::	0.2145	3.9619
61	4081	40	2747	0.5920	13.0975	::	0.2314	4.1933
121	9021	66	2750	0.9768	14.0743	::	0.2316	4.4249
115	8101	34	2803	0.5032	14.5775	::	0.2361	4.6610
127	9091	62	2827	0.9176	15.4950	::	0.2381	4.8991
116	8102	8	2925	0.1184	15.6134	::	0.2464	5.1495
85	5122	9	3116	0.1332	15.7466	::	0.2625	5.4080
82	5103	26	3235	0.3848	16.1314	::	0.2725	5.6805
39	3073	41	3269	0.6068	16.7382	::	0.2753	5.9558
130	9101	53	3303	0.7844	17.5226	::	0.2782	6.2340
112	8073	31	3305	0.4588	17.9814	::	0.2784	6.5124
8	1101	53	3386	0.7844	18.7657	::	0.2852	6.7976
56	4041	50	3433	0.7400	19.5057	::	0.2892	7.0868
45	3102	22	3934	0.3256	19.8313	::	0.3313	7.4181
15	2021	33	4479	0.4884	20.3197	::	0.3773	7.7954
59	4063	38	4610	0.5624	20.8820	::	0.3883	8.1837
18	2091	16	4742	0.2368	21.1188	::	0.3994	8.5831
84	5113	61	4823	0.9028	22.0216	::	0.4062	8.9893
110	8091	40	5231	0.5920	22.6136	::	0.4406	9.4299
33	3033	55	5325	0.8140	23.4276	::	0.4485	9.8785
73	5031	49	6492	0.7252	24.1527	::	0.5468	10.4253
7	1093	8	6604	0.1184	24.2711	::	0.5563	10.9815

TABLE A-4. FACTOR COMPLEXES SORTED FROM MINIMUM TO MAXIMUM AREA OCCUPANCY (CONCLUDED)

MAP UNIT	FACT CMPX	--TOTALS-- NOP	AREA	--NOP PERCENTS-- OCPY	ACUM	::	--AREA PERCENTS-- OCPY	ACUM
124	9041	58	6614	0.8584	25.1295	::	0.5571	11.5386
78	5092	75	6697	1.1100	26.2395	::	0.5641	12.1027
49	3122	66	6723	0.9768	27.2162	::	0.5663	12.6690
2	1031	44	7538	0.6512	27.8674	::	0.6349	13.3039
60	4073	47	7561	0.6956	28.5630	::	0.6369	13.9408
25	2103	37	7742	0.5476	29.1106	::	0.6521	14.5929
16	2031	81	7806	1.1988	30.3093	::	0.6575	15.2504
74	5032	14	7931	0.2072	30.5165	::	0.6680	15.9184
122	9031	48	7965	0.7104	31.2269	::	0.6709	16.5893
36	3043	54	9262	0.7992	32.0260	::	0.7801	17.3694
42	3092	116	9676	1.7167	33.7428	::	0.8150	18.1844
118	8113	44	9898	0.6512	34.3940	::	0.8337	19.0182
14	1134	92	10521	1.3616	35.7555	::	0.8862	19.9043
21	2092	92	11109	1.3616	37.1171	::	0.9357	20.8400
19	2073	18	11192	0.2664	37.3835	::	0.9427	21.7827
44	3101	147	11278	2.1755	39.5590	::	0.9499	22.7327
51	4021	115	11406	1.7019	41.2609	::	0.9607	23.6934
66	4102	54	12383	0.7992	42.0601	::	1.0430	24.7364
52	4031	228	12835	3.3743	45.4344	::	1.0811	25.8175
41	3091	85	13601	1.2580	46.6923	::	1.1456	26.9631
129	9093	100	14530	1.4799	48.1723	::	1.2239	28.1870
23	2101	95	16523	1.4059	49.5782	::	1.3917	29.5787
65	4101	221	16822	3.2707	52.8489	::	1.4169	30.9956
101	6134	61	16949	0.9028	53.7517	::	1.4276	32.4232
29	2134	139	17339	2.0571	55.8088	::	1.4605	33.8837
120	8134	167	17355	2.4715	58.2803	::	1.4618	35.3455
86	5134	99	17595	1.4651	59.7455	::	1.4820	36.8275
131	9103	34	22500	0.5032	60.2486	::	1.8952	38.7227
64	4093	153	22536	2.2643	62.5130	::	1.8982	40.6209
10	1103	45	22790	0.6660	63.1789	::	1.9196	42.5405
31	3031	196	23070	2.9007	66.0796	::	1.9432	44.4837
46	3103	120	24346	1.7759	67.8556	::	2.0507	46.5343
48	3113	115	27406	1.7019	69.5575	::	2.3084	48.8427
35	3041	70	27531	1.0360	70.5935	::	2.3189	51.1617
37	3051	111	27713	1.6427	72.2362	::	2.3343	53.4959
27	2113	84	28765	1.2432	73.4794	::	2.4229	55.9188
70	4122	93	30245	1.3764	74.8557	::	2.5475	58.4663
30	3021	162	33364	2.3975	77.2532	::	2.8103	61.2766
69	4113	191	38565	2.8267	80.0799	::	3.2484	64.5249
63	4092	177	43597	2.6195	82.6994	::	3.6722	68.1970
43	3093	205	55372	3.0339	85.7333	::	4.6640	72.8610
67	4103	119	64279	1.7611	87.4945	::	5.4142	78.2752
71	4134	407	103139	6.0234	93.5178	::	8.6874	86.9626
50	3134	438	154784	6.4822	100.0000	::	13.0374	100.0000

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