Research Product 87-16

TERRAIN AND CONTOUR MODEL INSTRUCTION

ARI Field Unit at Fort Benning, Georgia
Training Research Laboratory

April 1987

U.S. Army Research Institute for the Behavioral and Social Sciences

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Terrain association is the ability to interpret map information (e.g., contour lines) to the real world and to see the real world and be able to identify it on a map. The purpose of this report is to teach soldiers the relationship between the map and terrain. The product consists of a 1/:50,000 scale map sheet, contour model, terrain model, and the instructional material. The terrain model instruction is a transportable and low-cost training aid that can be used for reserve component, unit, instructional and school training.

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Training Land Navigation

FOREWORD

Terrain association, or the ability to interpret map information to the real world and vice versa, is one of the more difficult land navigation, map reading skills a soldier is required to learn and use. This skill is not only difficult to learn but it is also highly perishable.

In response to this problem, the Army Research Institute, in cooperation with the U.S. Army Infantry Center at Fort Benning, Georgia, developed the Terrain and Contour Model Instruction package. The original terrain model was made by the Defense Mapping Agency (then the Army Map Service, Corps of Engineers). This instructional material can be used as a review, as a self-paced text, or as part of any unit or institutional land navigation training.

EDGAR M. JOHNSON
Technical Director

TERRAIN AND CONTOUR MODEL INSTRUCTION

EXECUTIVE SUMMARY

Requirement:

This research product is instructional material for a terrain model developed in response to a need for improved training in map-to-terrain association. A modified version of the model, developed by the Army Map Service, Corps of Engineers (now the Defense Mapping Agency, Brookmont, MD), was incorporated with supporting instruction developed and tested by the Army Research Institute, Fort Benning Field Unit.

Procedure:

The terrain model and supporting instructional material was designed to supplement current map-to-terrain classroom/field instruction. Landforms are defined and problems are presented that require the student to understand contour line formations, terrain association, and the grid coordinate system.

Findings:

This terrain model instruction has the potential of providing effective, enhanced, low-cost, supplemental instruction for land navigation instruction.

Utilization of Findings:

Terrain model instruction can be used for unit, institutional, and school training. It may prove to be very effective for Reserve component training because of its transportability and low-cost. Additionally, it provides a "hands-on" aspect to training that is often lacking in current land navigation instruction.

TERRAIN AND CONTOUR MODEL INSTRUCTION

CONTENTS

TERRAIN AND CONTOUR MODEL INSTRUCTION

INTRODUCTION

Terrain association is the ability to interpret map information to the real world and to see the real world and be able to identify it on a map. In order to do this successfully, a soldier must understand the contour lines, which represent land forms; the Military Grid Reference System, which provides a method of locating points on a map; and the legend, which is the key to the map.

Although land navigation and its many components, such as terrain association and dead reckoning, are considered by the Army to be critical skills, very little is done in the institutional and unit setting to promote and sustain this highly perishable skill. The purpose of this instruction is to enhance and facilitate the learning of terrain association.

THE MODEL MODIFICATIONS

In its original form, the terrain model developed by the Army Map Service, Corps of Engineers (now the Defense Mapping Agency) consisted of three parts. On the far left was a flat topographic map. The fictitious landforms were represented in raised contour intervals in the center. The right section was entitled "Training Model," which consisted of a relief map. Contour lines, water features, man-made features, the grid reference system, and marginal information were superimposed on the underlying relief. The model was made of white acetate vinyl, which was heated and vacu-formed into shape.

The terrain model used in this research product varied from the original model in that the printed map information was not illustrated on the relief model. The rationale for this modification was that when soldiers view the real world, it is not represented with contour intervals and the grid reference system; therefore the transferability of the training benefits would be reduced if this information had been portrayed (i.e., soldiers must learn to "read" unmarked terrain). Additionally, this modification allows an instructor or student to draw contour lines, water features, or instructional highlights on the model.

THE TRAINING MATERIAL

Materials

The materials in this research product consist of the 1:50,000 scale map sheet (see Appendix A), a contour model (see Appendix B), a terrain model (see Appendix C), and the instructional book. In addition to these materials, the student needs a protractor and grid coordinate scale (GTA 5-2-12), pencil, and paper.

Objectives

The training objectives were three fold. First, the student was to be able to identify the eleven features on the terrain and contour models and on the map sheet. Second, the student was to be able to determine the grid coordinates for any point or feature identified on the terrain and contour models and the map sheet. Third, the student was to be able to see the relationship between the map and terrain.

TERRAIN AND CONTOUR MODEL INSTRUCTION

The following instructional package is designed to enhance terrain association, map reading, and land navigation training. It is designed to facilitate current "classroom" instruction and to bridge the gap between the classroom and field. It is NOT designed to replace any current instruction.

MATERIALS NEEDED

The materials include 1) a 1:50,000 scale map sheet (see Appendix A); 2) a contour model (see Appendix B); 3) a terrain model (see Appendix C); and 4) this instructional book. The student will need a protractor and grid coordinate scale (GTA 5-2-12), pencil and paper.

CONDITIONS OF LEARNING

Ideally, each soldier should have a map sheet, contour model, and terrain model. If this is not possible, the students should work in teams of no more than five (5).

This map sheet and the corresponding models are a fictitious piece of land designed for training purposes only. It was developed to expose students to important map to terrain concepts.

PURPOSE

The purpose of this teaching aid is to provide the learner with a better understanding of the relationship between the map and its corresponding "real world" configuration and vice versa. In other words, the student will understand how terrain features on the ground are represented by contour lines on the map.

TRAINING OBJECTIVES

By the end of this instructional unit, the student should be able to:

1. identify each of the following features on the terrain and contour models and on the map sheet:

Hill	Ridge
Valley	Saddle
Depression	Draw
Spur	Cliff
Cut	Fill
Ridgeline	

During training, the student will be required to:

1. determine the grid coordinates (up to 8 digits) for any point or feature identified on the:

Contour model
Terrain model
Map sheet

Since the grid is printed on the map only, students must correctly match designated points on the model with corresponding points on the map to determine the coordinates.

2. see the relationship between map and terrain.

SKILLS NEEDED

Prior to using this teaching aid, the student must understand two concepts: 1) contour lines and 2) the Military Grid Reference System. Additionally, the student must be familiar with the map legend and marginal information.

Since the primary purpose of this teaching aid is to provide the learner with a better understanding of the "real world" as it is represented on a map, a brief review of contour lines and the Military Grid Reference System is presented here. For a more thorough discussion of either of these concepts, the student is referred to FM 21-26 (1969, pp. 6-1 and 3-1, respectively).

REVIEW

Contour Lines

The plastic model has two parts: 1) a terrain model (right half), and 2) a contour model (left half). The terrain model depicts the hills and valleys, spurs and draws, etc. of the mapped terrain. In essence, it is a miniature representation of the terrain shown on the map. Contour lines are imaginary lines that connect points of equal elevation on the ground. Contour lines indicate vertical distance above or below sea level. The contour interval is

the vertical distance between adjacent contours. The contour interval on this map is 100 feet. This means that the vertical distance between adjacent contours would be one hundred feet on the ground. The contour model depicts the same terrain, but shows how the terrain would look if the elevation changed abruptly at each contour line. For every contour line shown on the map, there is a corresponding contour step on the contour relief map.

Every fifth contour is a heavier line than the intermediate contours and are called index contours. Index contours usually have an elevation value printed on them. The lighter lines between the index contours are called intermediate contours and represent 100 foot contour intervals. Supplementary contour lines are drawn with dashed lines (see lower left corner of map sheet). They provide additional elevation information, when needed. If a further discussion is needed on this topic, refer to FM 21-26 (1969, p. 6-1).

Military Grid Reference System

The Military Grid Reference System provides a method to locate specific points on a map. The grid lines, or parallel north-south and east-west lines mark-off 1,000 meter squares. To locate a point on the map, to within 1,000 meters, the grid square surrounding the point must be identified. Numbers along the margin of the map identify the north-south and east-west grid lines. First, read right and identify the last north-south grid line before arriving at the point to be located. Then, reading up, identify the last east-west grid line before the point.

Remember to read RIGHT (north-south lines) and UP (east-west lines). The numbers along the edge of the map are used to identify the grid square. For example, to identify the dammed lake, the north-south identifier is 88 and the east-west identifier is 72. Therefore, the dammed lake on your map sheet is located in grid square 8872.

There is one other important part of the grid coordinate identifier which needs to be included when referring to the grid square. It is the 100,000 meter square identifier. The two letter identifier is found in the marginal information. On this map, the identifier is GL. It is found on page 5 with the legend. The letter identifier goes before the number identifier. Therefore, the dammed lake on the map sheet is located in grid square GL8872. If a more precise location than a four digit grid coordinate is needed, then the grid square is divided into 100 meter or 10 meter increments. This adds two or four more numbers to the grid square identifier, respectively. To get this precision use a protractor and grid coordinate scale (GTA 5-2-12). Besides the azimuth circle, the protractor and grid coordinate scale contains three different scales to accurately measure grid square location. Care must be taken to use the proper scale. This information is found in the map margin. For this map, use the 1/50,000 meter index.

Place the 0-0 lines of the appropriate scale on the last north-south and east-west cross lines on the map before arriving to the point. Slide the meter scale to the point to be located, keeping the bottom line of the scale on the east-west line and the side line of the scale parallel to the north-south grid line. Read the number which intersects the north-south grid line (RIGHT). This number becomes the third number of the six digit coordinate. For example, the first three numbers for the center of mass of the dam on the lake are 881.

Now read the number that intersects the center of mass of the point to be located (UP). This is the sixth number of the six digit coordinate. The last three identifying numbers for the dam on the lake are 723. Thus, the dam is located at grid coordinates GL881723. Remember to locate the center of mass of the feature to be identified when determining the grid coordinates.

This precision can be extended to an eight digit number, which will identify a ten meter square area. Follow the procedure for determining a six digit grid coordinate. The north-south grid line intersects the bottom line of the scale, the fourth number of the grid coordinate represents a number on the scale which falls between the 100 meter identifiers. Thus, the first four numbers of the eight digit grid coordinate are 8805. Likewise, the eighth number of the eight digit coordinate is the number located on the center of mass, between the 100 meter identifiers. The last four digits identifying the river flowing from the dam are 7225. The eight digit grid coordinate for the river flowing from the dammed lake begins at coordinates GL88057225.

The most important point to remember is read RIGHT and UP. If more in-depth instruction is needed, refer to FM 21-26 (1969, p. 3-1).

The Legend

The legend usually appears in the lower left margin of the map. (This map sheet contains no legend; it is supplied here.) It is the map makers method of identifying mapped features. It consists of topographic symbols that are used to identify these features.

The following topographic symbols are used on this map:

Roads:

Primary all weather, hard surface, two or more lanes wide

Secondary all weather, hard surface, two or more lanes wide

Trail

Railroads:

Single track

Multiple track

Buildings or structures

Church; School

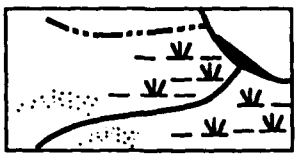
Horizontal control point (Checked spot elevation) 150

Vertical control point (Spot elevation) 720

Intermittent stream; Dam

Marsh or swamp

Sand



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scale 1/50,000
100,000 m square identification = GL
contour interval = 100 feet
map date = 1985

Colors:
Black = man-made features
Red-brown = 1. elevation and relief
2. classification of man-made features such as roads and built up areas
Blue = drainage or water features
Green = vegetation

PERFORMANCE MEASURES

Although the following is a progressive instructional approach, if the content seems to be too easy for the students' skill level, or is an unnecessary review, the instructional material will not lose its integrity if parts are by-passed. The items which are preceded by an asterisk (*) should NOT be omitted. Definitions for terrain features are provided. They are capitalized.

There may be more than one correct answer for each question. The student is encouraged to find at least one correct answer. The instructor should discuss some of the answers, which the students selected, with the class. Answers are provided on pages 10 to 13.

Orient Map

*1. The first step is to properly orient the map. By "orient" it is meant to align the map to the land, or in this case, to the terrain model. Thus, the hills and valleys should be correspondingly represented.

Terrain Features

2. A HILL IS A POINT OR SMALL AREA OF HIGH GROUND. WHEN LOCATED ON A HILL TOP, THE GROUND SLOPES DOWN IN ALL DIRECTIONS. ON A MAP, THE HILL TOP IS REPRESENTED BY THE LAST CLOSED CONTOUR LINE. THE HILL TOP IS LOCATED SOMEWHERE WITHIN THAT LAST CLOSED CONTOUR LINE (FM 21-26,1969).

*2a. Locate a hill on the map sheet. What is the eight digit grid coordinate for this hill?

*2b. Locate the same hill on the terrain model.

3. A RIDGELINE IS A LINE OF HIGH GROUND WITH CHANGES IN ELEVATION ALONG ITS CREST. WHEN LOCATED ON A RIDGELINE, IT SLOPES DOWN IN TWO DIRECTIONS AND IS FAIRLY LEVEL, YET UNEVEN, IN TWO DIRECTIONS. RADIATING FROM A RIDGELINE, THERE ARE USUALLY A SERIES OF DRAWS AND SPURS (FM 21-26, 1969).

*3a. Locate a ridgeline on the map sheet. What are the four digit grid coordinates for two easily identified points along this ridgeline?

4. A RIDGE IS A SLOPING LINE OF HIGH GROUND. WHEN LOCATED ON A RIDGE, LOW GROUND IS IN THREE DIRECTIONS AND HIGH GROUND IS IN ONE DIRECTION. RIDGES JUT OUT FROM LARGER LANDFORMS. THEY ARE REPRESENTED ON MAPS BY THE CLOSED END OF "V"S AND "U"S POINTING AWAY FROM THE HIGHER GROUND.

*4a. Find a ridge on the map sheet. What is the four digit grid coordinate for the high ground and for the low ground of the ridge?

5. A VALLEY IS REASONABLY LEVEL GROUND BORDERED ON THE SIDES BY HIGH GROUND. GENERALLY, A VALLEY HAS MANEUVER ROOM WITHIN ITS CONFINES. IT MAY OR MAY NOT CONTAIN A STREAM. WHEN ON THE GROUND, THE SIDES OF A VALLEY SLOPE UP IN THREE DIRECTIONS AND DOWN IN ONE DIRECTION. ON THE MAP, THE CONTOUR LINES FORM A "U" OR A "V" WITH THE BASE OF THE "U" OR "V" POINTING TOWARD HIGHER GROUND AND, IF A STREAM IS PRESENT, PARALLELS THE STREAM (FM 21-26, 1969).

*5a. Find a valley on the map sheet. Describe the contour line pattern.

*5b. Look on the map sheet. Does the valley have a stream?

6. A SADDLE IS A DIP OR LOW POINT ALONG THE CREST OF THE RIDGELINE. THE GROUND IS LOW IN TWO OPPOSITE DIRECTIONS AND HIGH IN TWO OPPOSITE DIRECTIONS. WHEN IN A SADDLE, THERE IS HIGHER GROUND IN TWO OPPOSITE DIRECTIONS AND LOWER GROUND IN TWO OPPOSITE DIRECTIONS. THE CONTOUR LINES FORM AN HOUR GLASS OR FIGURE EIGHT (FM 21-26, 1969).

*6a. Find a saddle on the contour model. Describe the specific contour pattern.

*6b. Find the corresponding saddle on the map sheet. What is the eight digit grid coordinate for this saddle (low point)?

7. A DEPRESSION IS A LOW POINT SURROUNDED ON ALL SIDES BY HIGHER GROUND. ON THE MAP, IT IS REPRESENTED BY A CONTOUR LINE, WITH TICS POINTING TOWARD THE LOW GROUND. WHEN STANDING IN A DEPRESSION, HIGHER GROUND IS SEEN IN ALL DIRECTIONS (FM 21-26, 1969).

*7a. Find a depression on the map sheet. What is the elevation of the depression?

8. A DRAW IS SIMILAR TO A VALLEY. IT MAY OR MAY NOT CONTAIN A STREAM. THERE IS LITTLE OR NO MANEUVER ROOM. CONTOUR LINES REPRESENTING A DRAW FORM A "U" OR A "V" WHICH POINTS TOWARD THE HIGH GROUND. ON THE GROUND, THE DRAW SLOPES UP IN THREE DIRECTIONS AND DOWN IN ONE DIRECTION (FM 21-26, 1969).

*8a. Locate a draw on the terrain model and the corresponding draw on the contour model. Before finding the draw on the map sheet, sketch its contour lines on a piece of paper. Check the drawing with the map sheet.

9. A SPUR IS A SMALL RIDGE, OR A CONTINUOUSLY SLOPING LINE OF GROUND JUTTING FROM THE SIDE OF ANOTHER LANDFORM. IT IS OFTEN FORMED BY TWO ROUGHLY PARALLEL STREAMS CUTTING DRAWS DOWN THE SIDE OF A RIDGE. WHEN YOU ARE ON A SPUR, THE GROUND SLOPES DOWN IN THREE DIRECTIONS AND UP IN ONE DIRECTION. THE CONTOUR LINES OF A SPUR FORM A "U" OR A "V" WHICH POINTS TOWARD THE LOW GROUND (FM 21-26, 1969).

*9a. Identify a spur on the map sheet.

*9b. Find the same spur on the terrain model.

10. A CLIFF IS A VERTICAL OR NEAR VERTICAL SLOPE REPRESENTED BY CLOSE CONTOUR LINES (ALMOST TOUCHING). WHEN A CLIFF IS TOO STEEP TO BE SHOWN ON THE MAP WITHOUT THE CONTOUR LINES OVERLAPPING, IT IS REPRESENTED ON THE MAP BY A CONTOUR LINE WITH TICK MARKS POINTING TOWARD THE LOWER GROUND (FM 21-26, 1969).

*10a. A cliff is not represented on the map sheet and models. The land form at grid coordinate GL901678 may look like a cliff because of the steepness of its slope relative to the other land forms. However, because its contour lines do not over-lap and there are no ticks, this feature is not a cliff.

11. A CUT IS A MAN-MADE FEATURE WHERE HIGH AREAS ARE LEVELED SO ROAD AND RAILROAD CONSTRUCTION IS MADE EASIER. ON A MAP, THE CONTOUR LINES USUALLY APPEAR STRAIGHT AND MAY CONTAIN TICS, POINTING TOWARD THE LEVELED GROUND, REPRESENTING A LARGE DIFFERENCE IN ELEVATION BETWEEN THE SURROUNDING GROUND AND THE MAN-MADE SECTION (FM 21-26, 1969).

*11a. Draw how a cut would be represented by contour lines. Find a cut on the map sheet.

*11b. Locate the same cut on the contour model and on the terrain model. What is the eight (8) digit grid coordinate for the cut (center of mass)? Why was the cut made?

12. LIKE A CUT, A FILL IS ALSO A MAN-MADE FEATURE. LOW AREAS ARE FILLED-IN TO PROVIDE A PATH FOR MAN-MADE FEATURES SUCH AS ROADS OR RAILROADS. ON A MAP, THE CONTOUR LINES USUALLY APPEAR STRAIGHT AND MAY CONTAIN TICS POINTING AWAY FROM THE FILLED-IN AREA, REPRESENTING LARGE DIFFERENCES BETWEEN THE MAN-MADE AREA AND THE SURROUNDING TERRAIN (FM 21-26, 1969).

*12a. Find a fill on the map sheet. Why was this fill made?

*12b. Locate the corresponding fill on the contour model.

Slope

13. SLOPE IS THE INCLINE OF THE EARTH'S SURFACE. SLOPES VARY IN STEEPNESS AND FORM. STEEPNESS AND FORM OF THE SLOPE IS DETERMINED BY THE SPACING OF THE CONTOUR LINES. CLOSELY SPACED CONTOUR LINES REPRESENT STEEPER SLOPES AND CONTOUR LINES SPACED FURTHER APART REPRESENT GENTLER SLOPES. TWO FORMS FOR SLOPES ARE CONVEX AND CONCAVE. A CONVEX SLOPE IS STEEPER NEAR THE BOTTOM THAN THE TOP OF THE INCLINE. A CONCAVE SLOPE IS STEEPER NEAR THE TOP THAN THE BOTTOM OF THE INCLINE.

*13a. Find a convex slope on the contour model. What is the four digit grid coordinate for two points along this slope?

*13b. Find a concave slope on the contour model. What is the four digit grid coordinate for two points along this slope?

*13c. How do the contour lines differ for a convex and concave slope?

*13d. How do you recognize slope (steepness) on a map sheet?

*

13e. Locate GL895711 to GL905695 and GL815735 to GL825715. Contrast their respective slopes. Locate the corresponding slopes on the contour model.

Route Planning

*14. By using the map sheet, select a route between Hill 1505 (GL81887410) and Hill 1009 (GL90277145) on foot (path of least resistance).

*14a. Check the contour model to see if your indicated route is correct.

*15. How would the route selected be different if you were traveling mounted?

*15a. Check the contour model to see if the changes you made were good ones.

*16. Locate the railroad on the map sheet. Follow the tracks' corresponding course on the terrain model.

REVIEW

1. Check and be sure you understand each landform listed below and can easily identify it on the map and terrain model:

Hill	Ridge
Valley	Saddle
Depression	Draw
Spur	Cliff
Cut	Fill
Ridgeline	

2. Are there symbols on the map you do not understand? Ask your instructor.

3. What are the differences between contour model and terrain model?

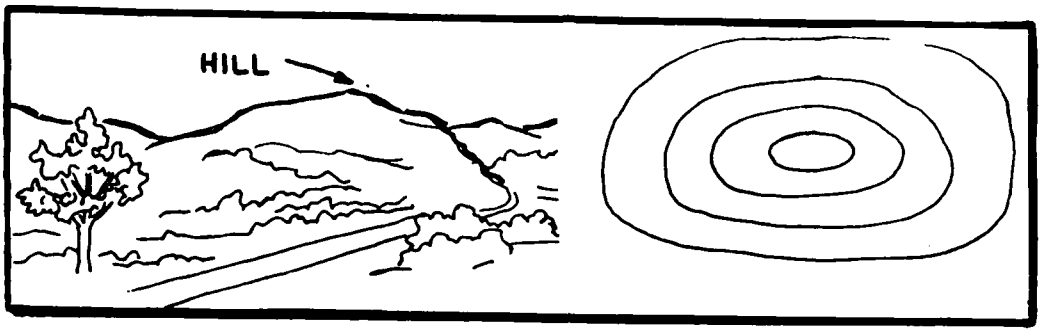
ANSWERS

1) Orient map

The map is properly oriented when the numbers in the margin, which correspond to the grid lines, are located at the bottom and to the right of the map and the contour model is to the left of the terrain model.

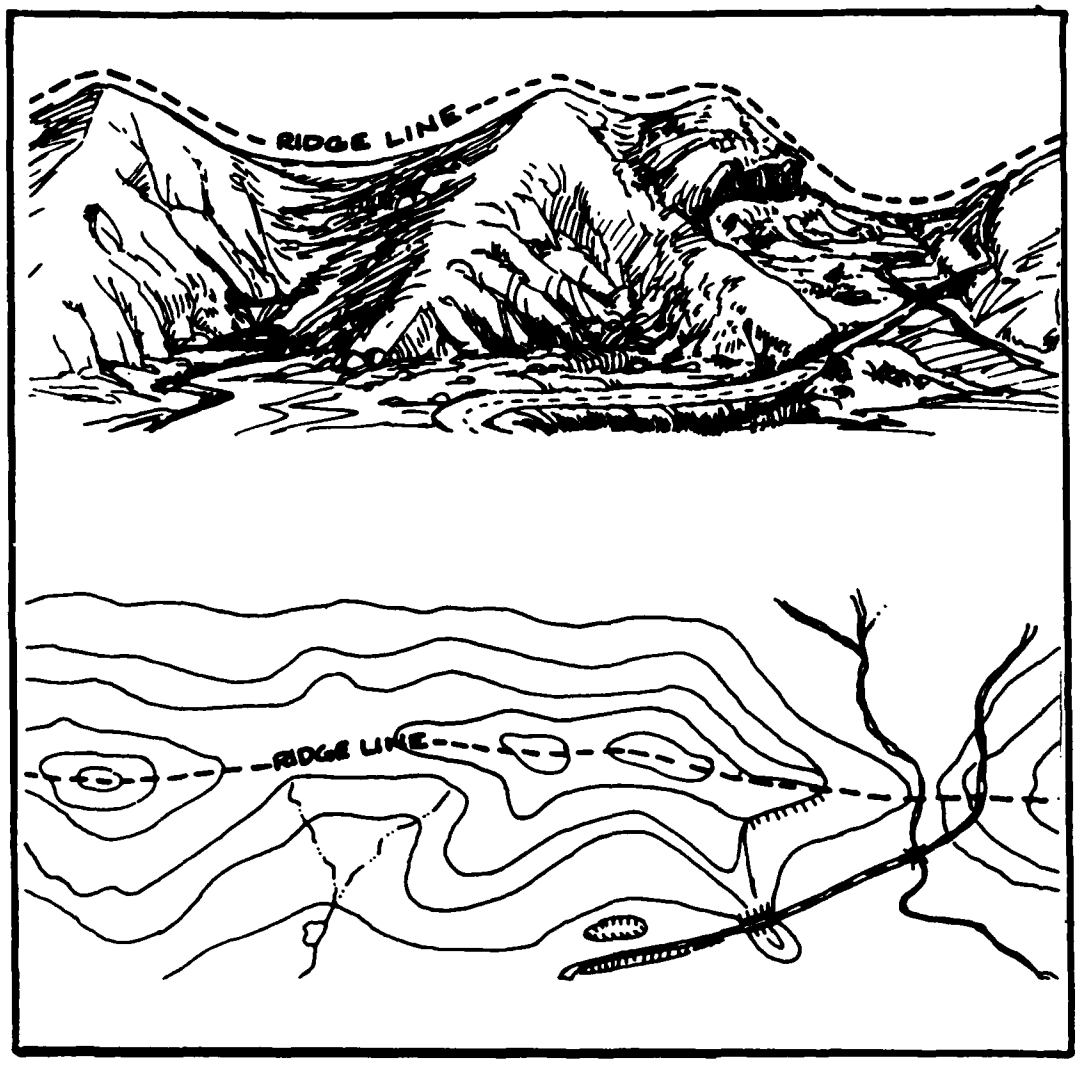
2) Hill

GL81557585 GL81857410 GL83997405 GL84007023 GL84797029 GL85207054 GL85507055 GL85757036 GL82507075 GL86107645 GL91007320 GL91207725 GL87957325 GL88807343 GL89697110 GL90267144 GL90617185 GL88097145 GL89747364 (Remember to read RIGHT and UP)



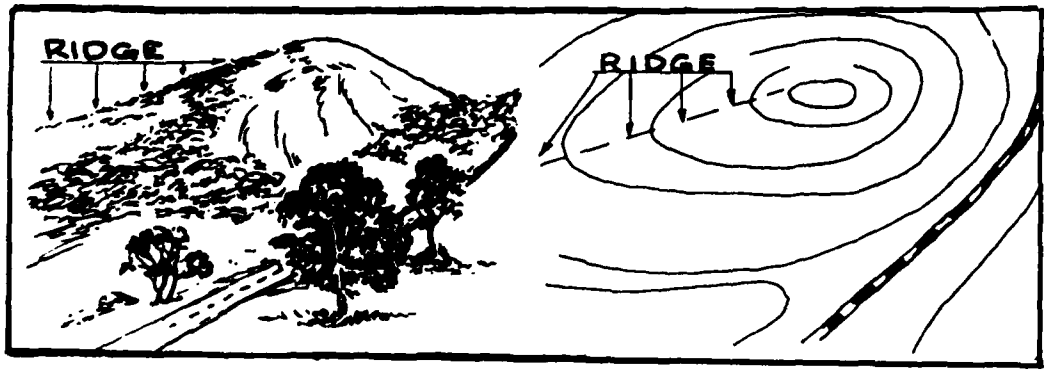
3) Ridgeline

A ridgeline extends from horizontal control point 1505 (GL8174) to horizontal control point 1435 (GL8676). Another ridgeline extends from GL8971 to GL9071 including BM 1009.



4) Ridge

The following are ridges: GL8173 to GL8271, GL8574 to GL8672, GL8676 to GL8874, GL8876 to GL8874, GL9076 to GL8974, GL9174 to GL9074, GL9072 to GL8973, GL8970 to GL8769, GL8469 to GL8367

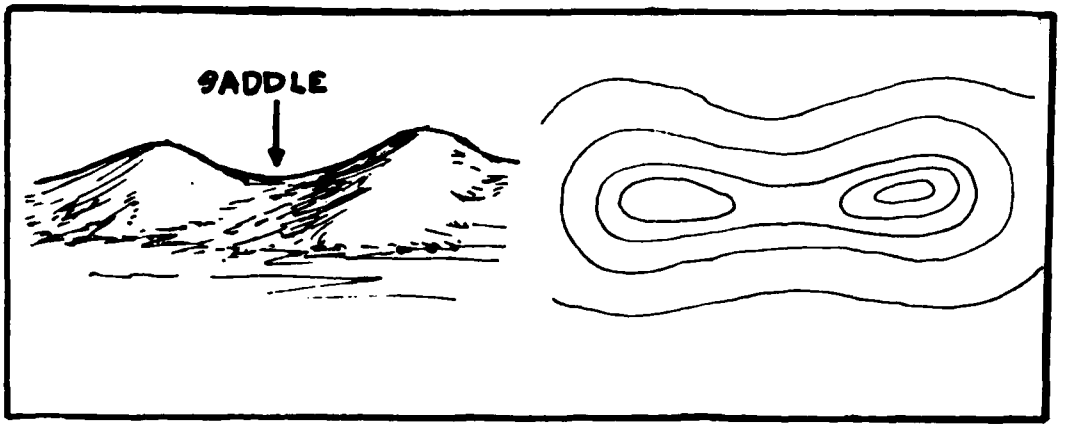


5) Valley

A valley extends the length of the railroad. Another valley extends the length of the major water way from GL8867 to GL9168. The valley does have a stream.

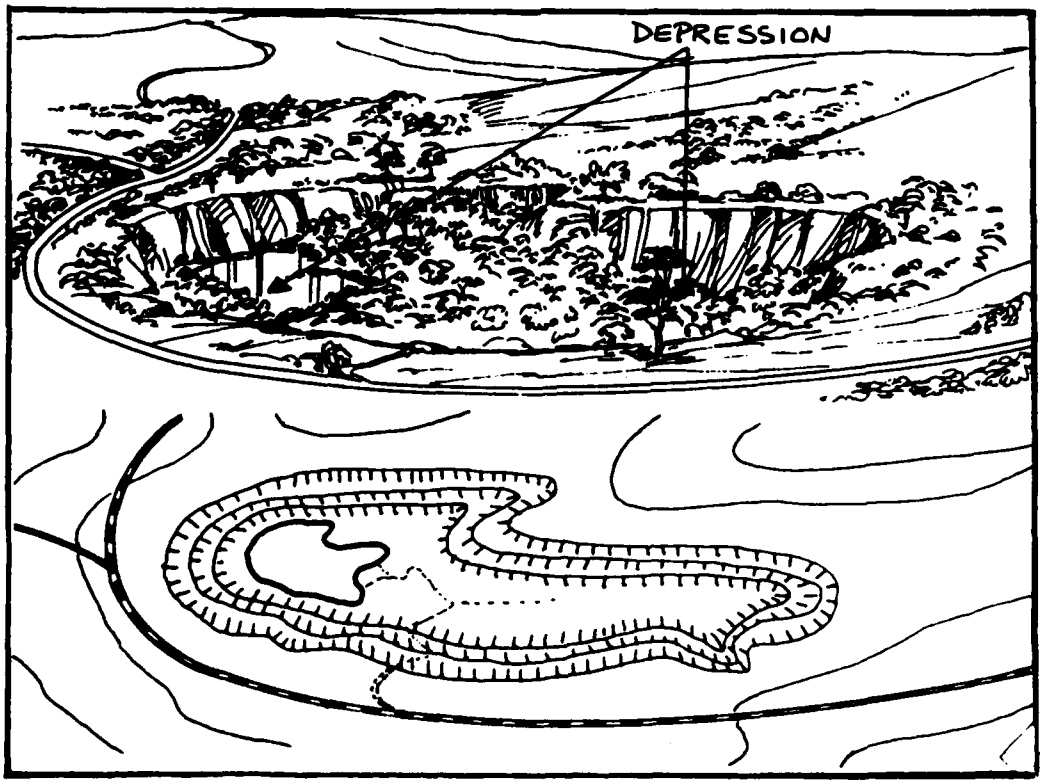
6) Saddle

A saddle can be found at the following coordinates: GL85397055 (low point), GL9007125 (low point), and GL90477165 (low point). A saddle is an hourglass form or a figure eight.



7) Depression

There are two depressions on the map: GL84187255 (250 feet) and GL84747254 (450 feet).

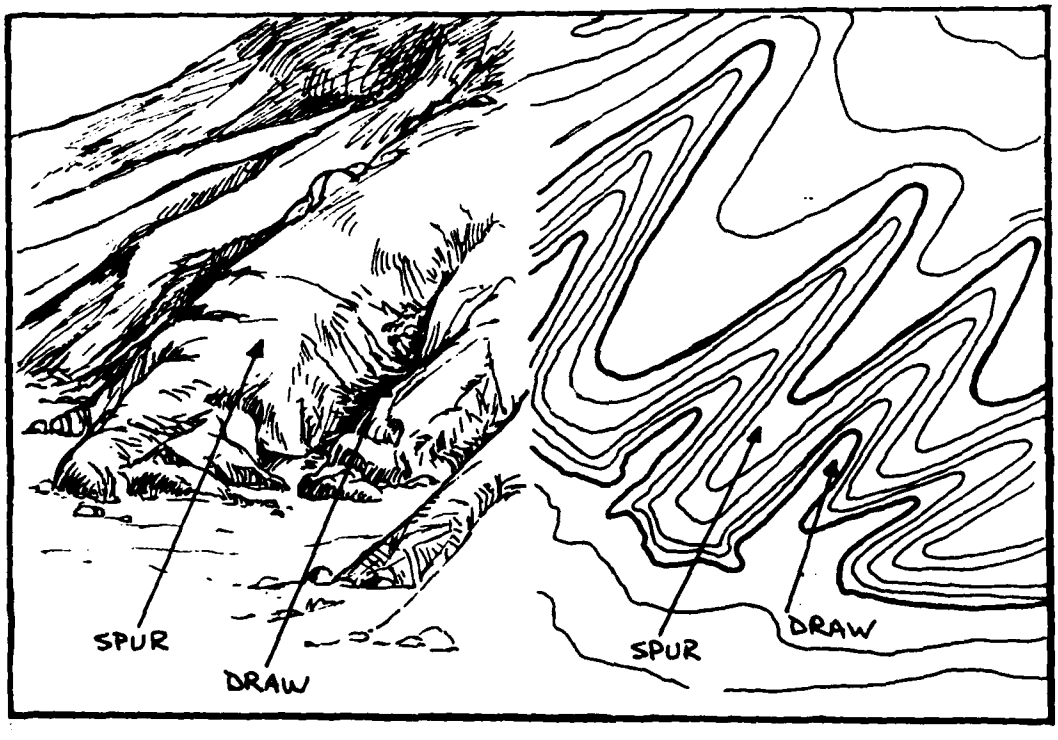


8) Draw

Draws are located between the following coordinates: GL8072 to GL8172 has 3 draws extending in a southwest direction; GL8273 to GL8371 has 3 draws extending in a near southern direction.

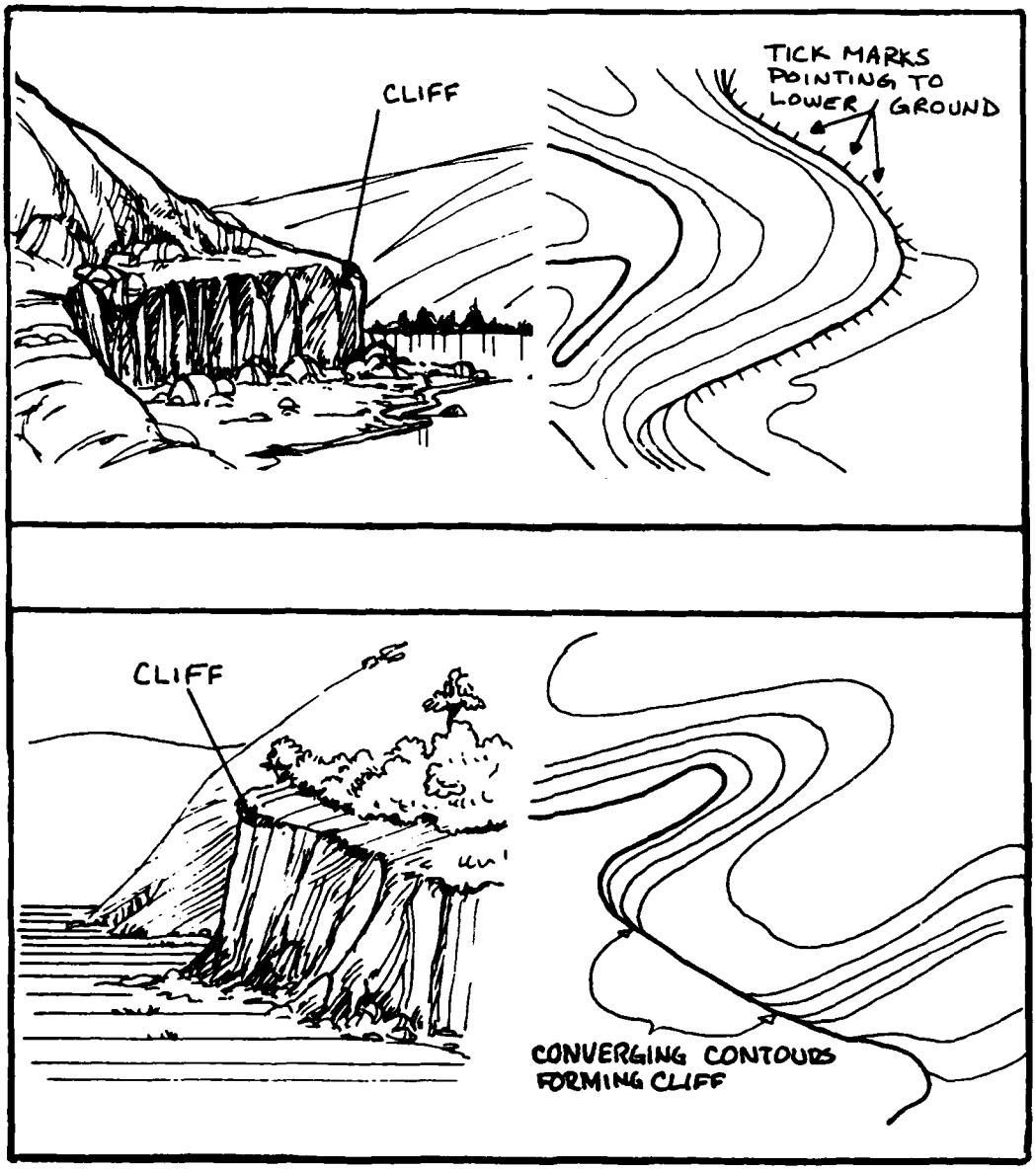
9) Spur

Spurs are located between the following coordinates: GL8073 to GL8171 has 4 spurs extending in a southwest direction; GL8273 to GL8371 has 2 spurs extending in a near southern direction; GL8272 to GL8271 has a spur which extends in a southern direction.



10) Cliff

Does not require an answer.

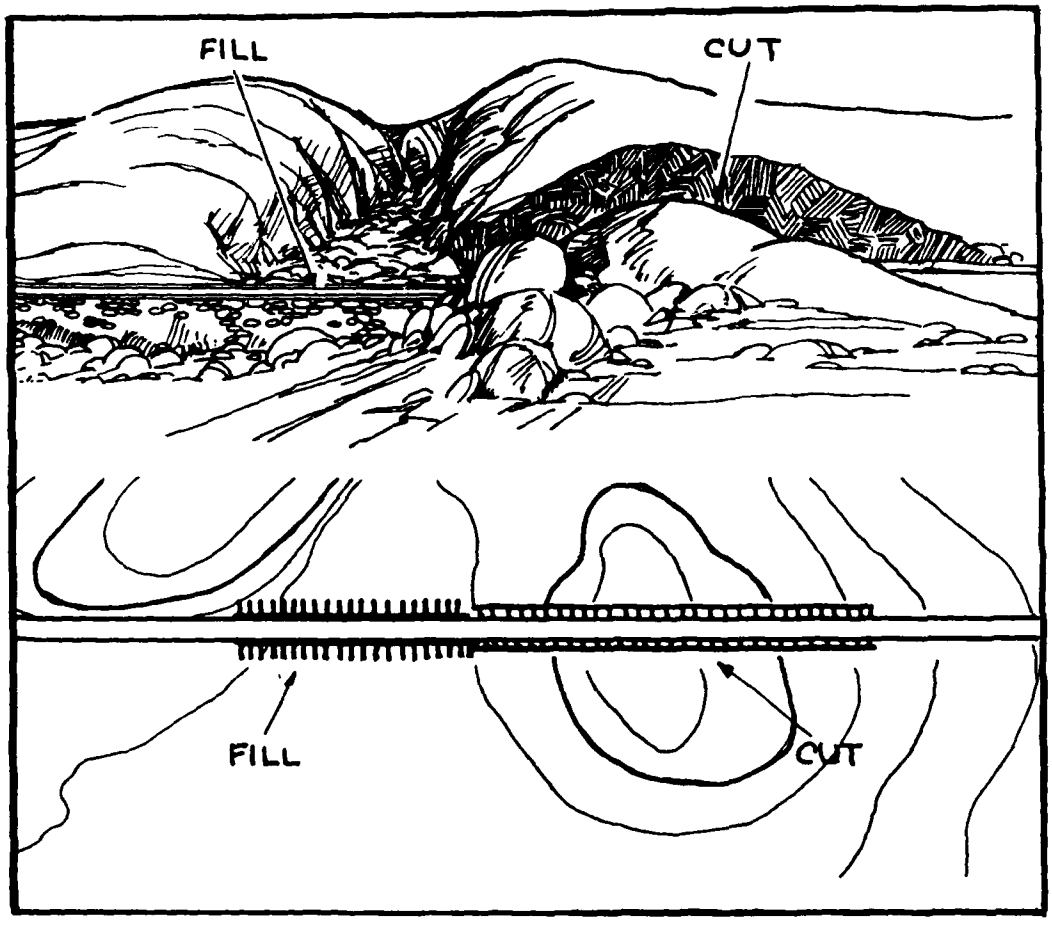


11) Cut

A cut is located at GL83157210. It was made for the road.

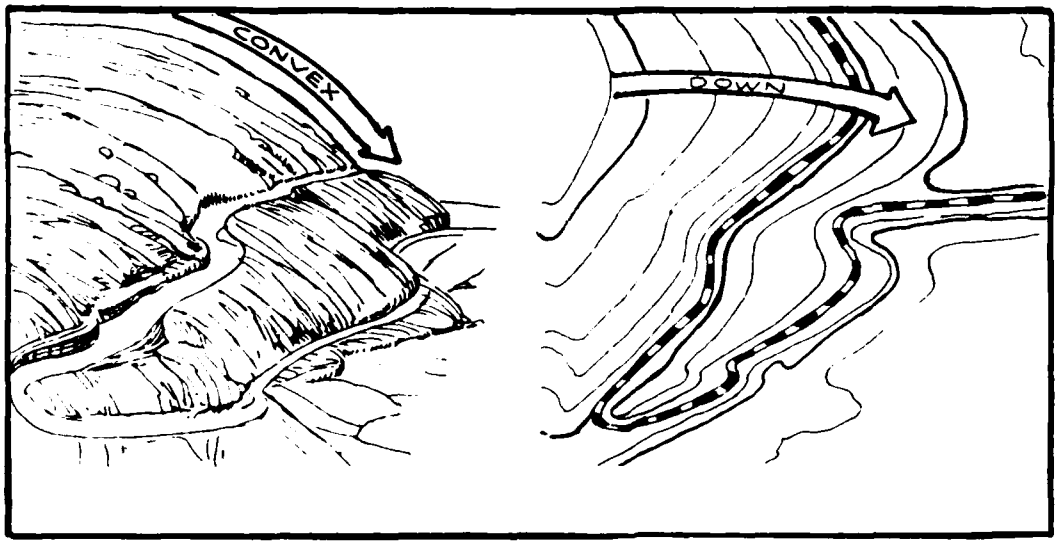
12) Fill

A fill is located at GL85407290. It was made for the road.



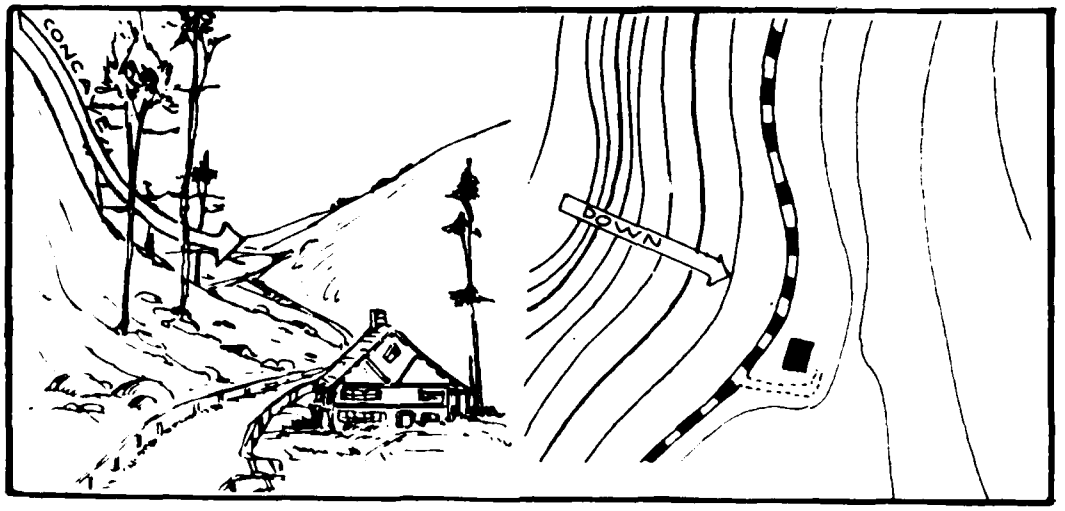
13) Convex slope

The following are convex slopes: GL8975, GL82272 to GL8271, and GL8874 to GL8875. Contour lines are evenly spaced near the top of the slope and become close together as they near the bottom.



13) Concave slope

A concave slope is represented at coordinate GL8576. Contour lines are close near the top of the slope and become evenly space near the bottom.



13) Steepness

The steepness of a slope is represented on a map by the contour configuration. The closer together the contour lines, the steeper the slope. Conversely, the further apart the contour lines are, the more gentle the slope.

The terrain in the lower right portion of the map (GL895711 to GL905695) is gently sloped; the contour lines are evenly spaced. The elevation is sea level (50 feet) to the hilltop (1050 feet). The area identified by grid coordinates GL815735 to GL825715 is a convex slope. The contour lines are evenly spaced near the top of the slope and become close together near the mid-bottom of the slope. The elevation of this area is 500 feet to 1350 feet.

14) Path of least resistance (4 options, prioritized from easiest to hardest)

a. From Hill 1505 head in an East/Northeast direction to approximately grid coordinate GL82907435. At that point turn South/Southeast to grid coordinate GL85237280. Cross the fill to grid coordinate GL85867316 and head East/Southeast crossing the road twice, once at GL86617309 and again at GL86847306. From that point head due East across the railroad track, stream and road and head for the dam vicinity GL88087221. After crossing the dam, begin heading uphill in an Easternly direction to Hill 1009.

b. From Hill 1505 head South, down the draw to the stream junction at GL82847137. Follow the stream due East until it intersects with the railroad tracks at GL86857200. From there, head in a general East/Southeast direction to Hill 1009.

c. From Hill 1505 head East/Northeast along the ridge to grid coordinate GL8475. Turn South/Southeast to intersect the trail leading from the tower. Follow the trail down to the hard surface road, turn left, cross the fill, and proceed to coordinate GL86077310. From that point head South/Southeast to grid coordinate GL87657075. Then head in an Easternly direction, up hill, to Hill 1009.

d. From Hill 1505 head in an East/Northeast direction to the vicinity of Hill 1435. Proceed down the ridge to the railroad bridge at grid coordinate GL88667426. From there, cross the stream, and head in a Southernly direction to Hill 1009.

15) Path of least resistance for a combat vehicle

Path of least resistance for a combat vehicle from Hill 1505 head in an East/Northeast direction to approximately grid coordinate GL82907435. Head in an East/Southeast direction to the tower at grid coordinate GL84167405. Follow the trail to the road junction (GL85117275). Follow the road over the railroad tracks and stream and the stream again to approximately grid coordinate GL87347160. Leave the road and travel in an Easternly direction to Hill 1009.

16) Railroad

The railroad extends the length of the major water way from GL8867 to GL9168.

Other features:

Dam
GL88077224

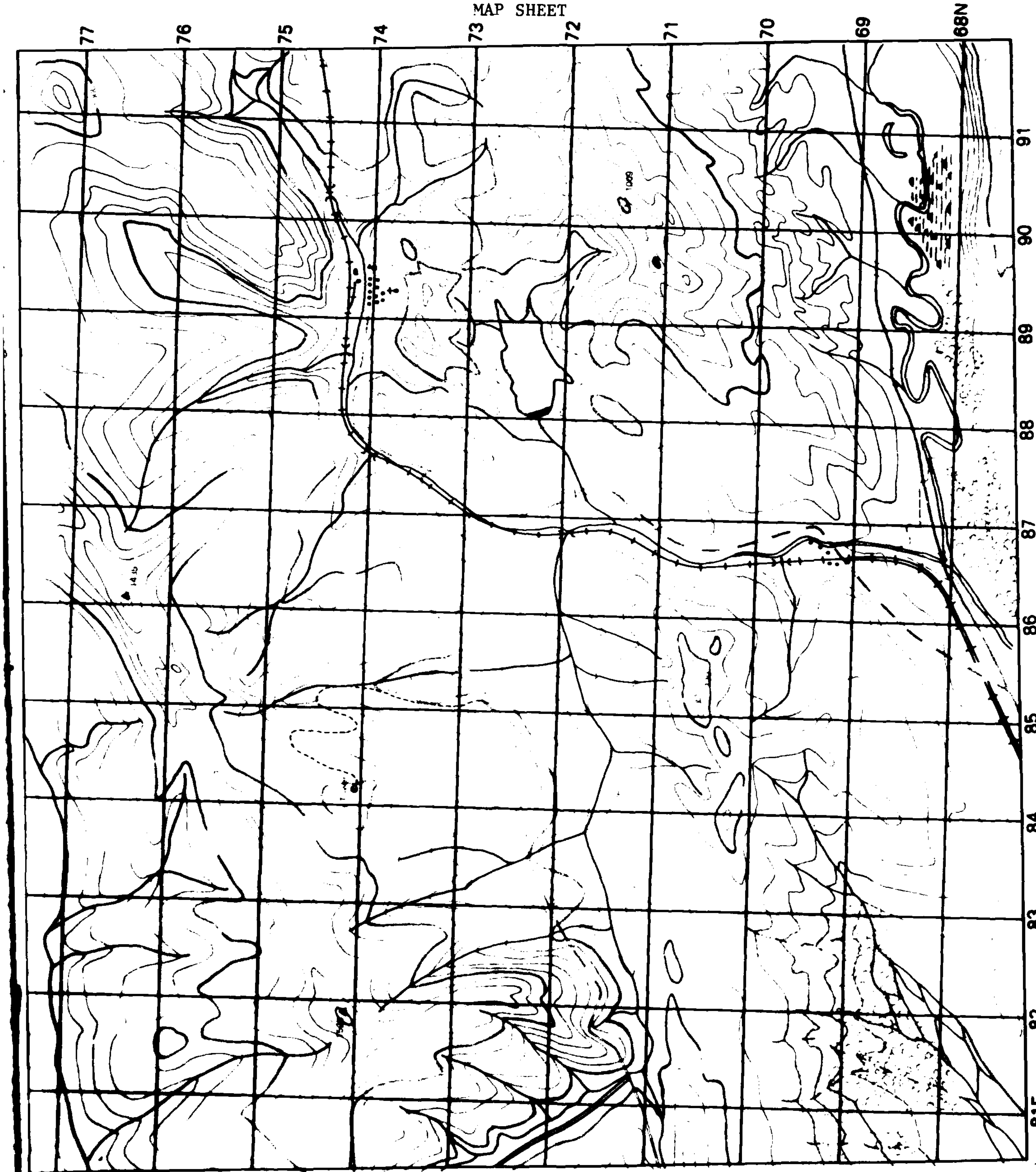
River from Dam
GL88067226

Marsh
GL90316829

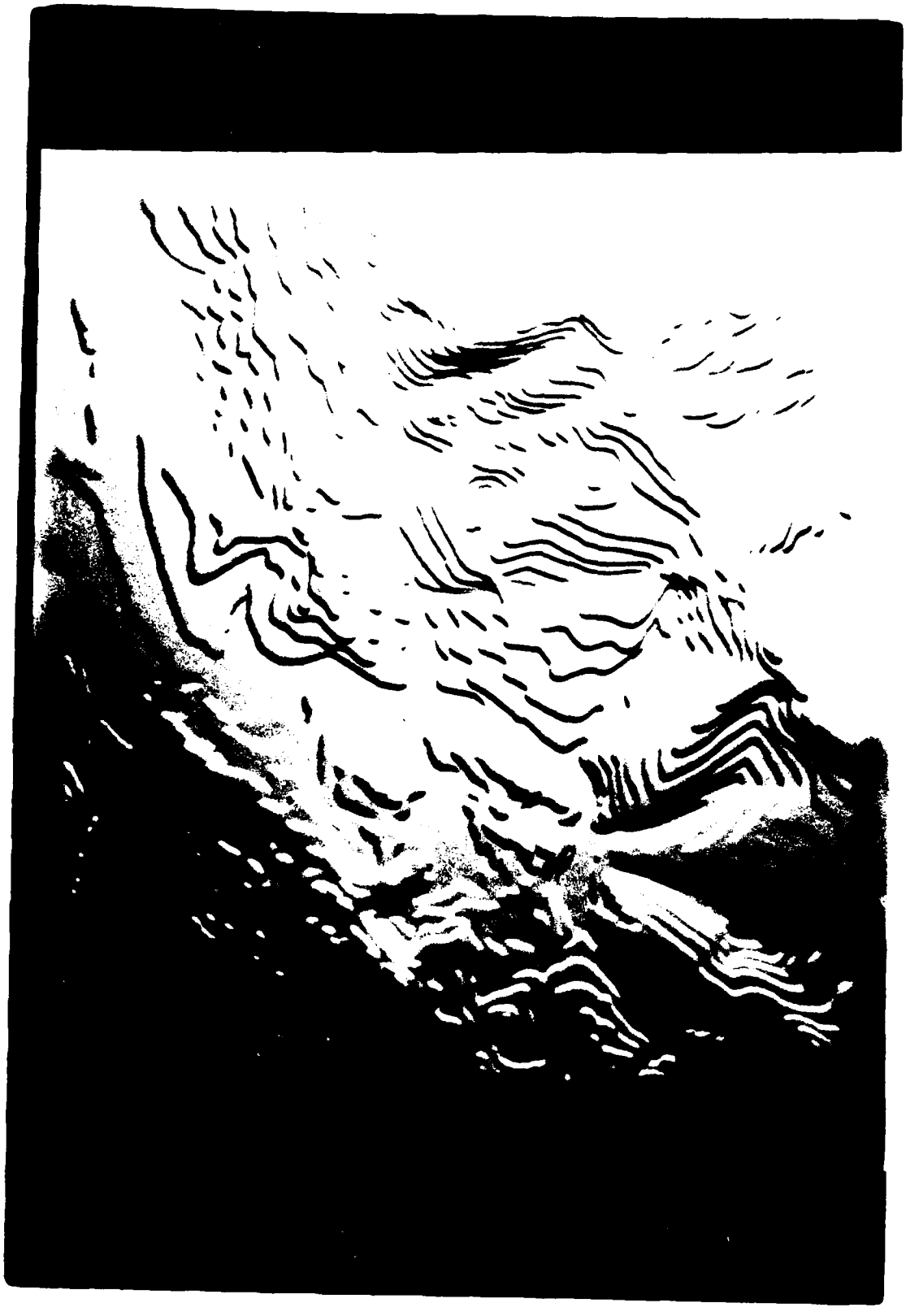
96006 Army-Ft. Benning, Ga. Dec 85

APPENDIX A

MAP SHEET



APPENDIX B
CONTOUR MODEL



APPENDIX C
TERRAIN MODEL