DOCUMENT RESUME

ED 103 236		SE 018 517

TITLE	Contour Mapping, An Environmental Investigation.
INSTITUTION	Minnesota Environmental Sciences Foundation, Inc., Minneapolis.; National Wildlife Federation, Washington, D. C.
PUB DATE	72
NOTE	24p.; Related documents are SE 018 514-534
AVAILABLE FROM	National Wildlife Federation, 1412 16th Street, N.W., Washington, D.C. 20036 (Order No. 79212, $1.50)
EDRS PRICE	MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS	Elementary Grades; *Environmental Education; Instructional Materials; Intermediate Grades; Junior High Schools; *Learning Activities; *Mathematics Education; *Science Education; Secondary Grades; Teaching Guides
IDENTIFIERS	*Mapping

ABSTRACT

This environmental unit is one of a series designed for integration within an existing curriculum. The unit is self-contained and requires little teacher preparation. The philosophy of this series is based on an experience-oriented process that encourages self-paced independent student work. This particular unit is designed to involve students in contour mapping activities that demonstrate certain principles of geometry. Preliminary activities include directions for building contour mapping equipment. The remaining activities are concerned with the use of this equipment in constructing a contour map. At the end of the unit are six pages ofgraphic information that can be duplicated and distributed to the students. Teacher information includes materials needed, directions for assembling equipment, background information, and additional topics. This unit is designed for students, grades 4-9. (MA)

edited and published by
NATIONAL WILDLIFE FEDERATION
written by
MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

THE ENVIRONMENTAL UNITS

This is one of a group of Environmental Units written by the Environmental Science Center and published by the National Wildlife Federation.

In both theory and practice education is the essential base for long range local, regional and national programs to improve and maintain the quality of environment necessary for man's welfare and survival. Citizens must be aware of ecological relationships in order to recognize, appreciate and fulfill constructive roles in society. This awareness should be launched through the existing educational process—in classroom and related school activities. No special courses on ecology can replace the need to integrate ecological learning throughout the existing curricula of our school systems. Furthermore, the life-styles and value-systems necessary for rational environmental decisions can best be acquired through repeated exposure to ecological learning which pervades the total educational experience.

It was with these thoughts that we developed these curriculum materials. They were designed for the classroom teacher to use with a minimal amount of preparation. They are meant to be part of the existing curriculum—to complement and enhance what students are already experiencing. Each unit is complete in itself, containing easy-to-follow descriptions of objectives and methods, as well as lists of simple materials.

The underlying philosophy throughout these units is that learning about the environment is not a memorization process, but rather an experience-oriented, experiment-observation-conclusion sort of learning. We are confident that students at all levels will arrive at intelligent ecological conclusions if given the proper opportunities to do so, and if not forced into "right" answers and precisely "accurate" names for their observations. If followed in principle by the teacher, these units will result in meaningful environmental education.

In the process of development, these units have been used and tested by classroom teachers, after which they have undergone evaluations, revisions and adaptations. Further constructive comments from classroom teachers are encouraged in the hope that we may make even more improvements.

A list of units in this group appears on the inside back cover.

About the National Wildlife Federation—1412 Sixteenth Street, N.W., Washington, D.C. 20036

Founded in 1936, the National Wildlife Federation has the largest membership of any conservation organization in the world and has affiliated groups in each of the 50 states, Guam, and the Virgin Islands. It is a non-profit, non-governmental organization devoted to the improvement of the environment and proper use of all natural resources. NWF distributes almost one million copies of free and inexpensive educational materials each year to youngsters, educators and concerned citizens. Educational activities are financed through contributions for Wildlife Conservation Stamps.

About the Environmental Science Center—5400 Glenwood Avenue, Minneapolis, Minnesota 55422

The Environmental Science Center, established in 1967 under Title III of the Elementary and Secondary Education Act is now the environmental education unit of the Minnesota Environmental Sciences Foundation, Inc. The Center works toward the establishment of environmental equilibrium through education—education in a fashion that will develop a conscience which guides man in making rational judgments regarding the environmental consequences of his actions. To this end the Environmental Science Center is continuing to develop and test a wide variety of instructional materials and programs for adults who work with youngsters.

Contour Mapping

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

Design and Illustrations by

JAN BLYLER

Contour mapping is fun. It involves children in the out-of-doors, and it painlessly introduces them to geometry. No technical terms are used, no complicated numbers are computed. The children merely participate in activities which *demonstrate* underlying concepts of geometry.

But contour mapping also has ecological significance. The distribution of plants and animals in a given area will form a pattern in harmony with the physical characteristics of that area. This is true partly because *elevation variations* and *slope angles* both have important influence on vegetation cover. In fact, striking differences can often be observed in size and type when plants of one elevation are compared with those of a significantly different elevation—especially in areas relatively undisturbed by man. Observations of this type will serve to demonstrate to the children that various elements of the environment work together, and that nothing is isolated from its surroundings.

We hope you will use **Contour Mapping** as a launching pad for other environmental investigations.

Table of Contents

INTRODUCTION

A **contour map** is a graphic representation of a part of the earth's surface, plotted to a definite scale. Its distinguishing characteristic is that it portrays the **shape** and **elevation** of the terrain. The contour map is a two-dimensional representation of a portion of the three-dimensional earth.

This unit presents techniques for teaching contour mapping on a small scale, and methods for preparing equipment for that purpose. The equipment is inexpensive. Most of it can be built by the children at home or in class. The only major prerequisite for the unit involves locating a suitable hill to investigate.

Before introducing the unit to the class, it is strongly advised that you build a set of the contour mapping equipment yourself and practice its use. This will help you assist the children when they carry out the activities necessary for making their own contour map.

After the contour map of the site is made, the class will investigate plant populations. Vegetation patterns can be correlated with topology by establishing a **transect** or **guideline** which is roughly perpendicular to the contour lines. Plant samples are collected or observed along this guideline, with special attention given to the type and size of the plants. A vegetation profile will result. The profile is useful in helping students see some relationships between changes in plant forms and changes in topology.

Once a transect is established, additional environmental factors such as soil type, light intensity, and temperature may also be investigated. (You might want to see **Transect Studies,** or **Soil**—other related units in this series.)

You may also want to pursue the theme of this unit by introducing some "real" problems the group could work on. Several sample problems are provided at the end of the unit.

Contour Mapping is designed as a starting point. We hope you will use it as a beginning for other investigations into the environment.

MATERIALS

- 6 oz. juice cans
- thread
- masking tape
- colored tape, red, black
- hammers
- rope, 30' lengths
- compass
- nails
- teardrop sinkers
- clear pine poles (1" x 2" x 4')
- clear pine poles (1" x 1" x 8')
- black grease pencils
- scrapwood, 8" lengths
- cup hooks, small

Contour Mapping

Building the Equipment

Contour mapping is relatively easy if the proper equipment is available. This section describes some simple methods for constructing inexpensive tools. Gather together the materials from page 3 and set aside several periods for assembling them. The children could build the equipment at home, but they may enjoy it more doing it together as a class project. Your supervision will help insure some standardization among the various pieces built.

Basically the equipment consists of four pieces of apparatus: a range pole, a sighting device, stakes, and a rope marked in three-foot intervals. Each group of three children should have one of each piece, except for the stakes, of which they should have about ten.

To give you a rough idea of how these pieces of equipment work, (detailed instructions begin on page 6), the sighting device will be used by one team member at a certain point along a slope. By looking through the small opening in one end of the device, and focusing on the point at the other end where two threads cross, that team member's vision will be tunnelled in a line which is perpendicular to the support stick of the sighting device. Another team member will be moving a range pole along the ground, up the hill from the first student, until a predetermined mark on the pole can be viewed by the first student through the sighting device. Next, the marked rope is used to measure the horizontal distance between the sighting device and the range pole. That horizontal distance is recorded and then the sighting device is moved to the point where the range pole is located. The range pole is moved farther up the hill and the entire procedure is repeated.

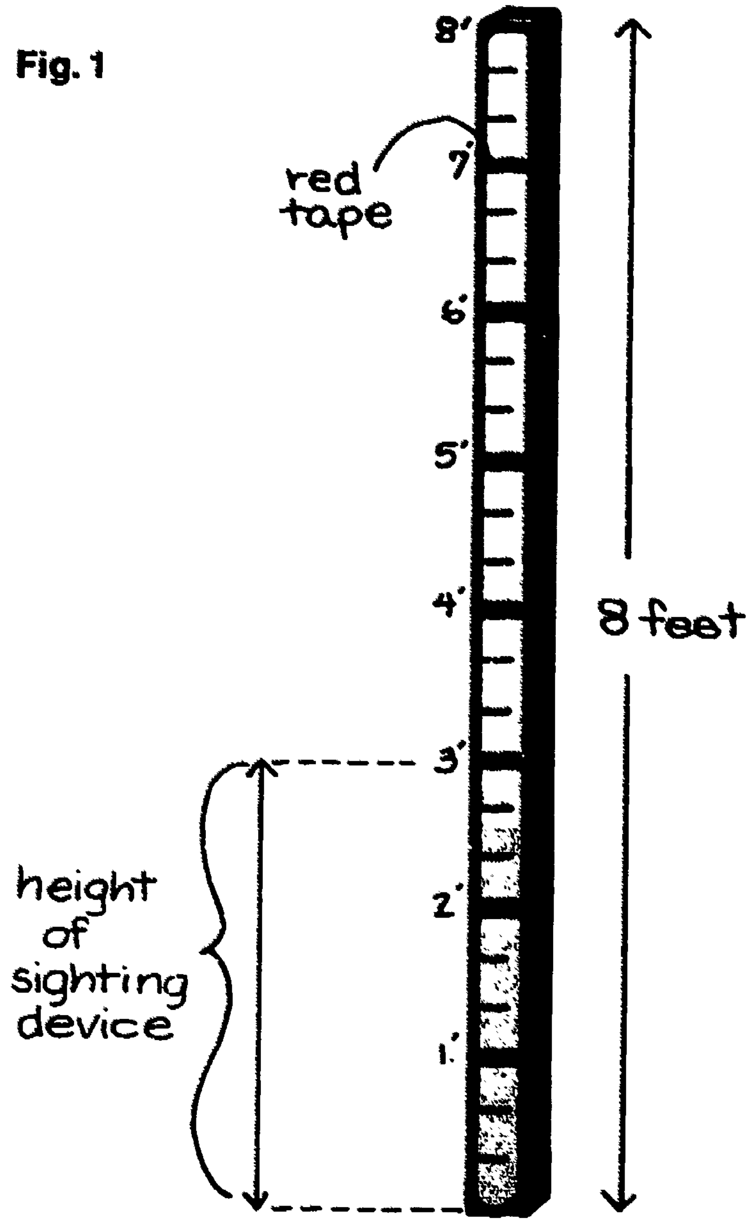
Directions follow for the construction of each piece of equipment used in these contour mapping activities.

I. Range Pole

Measure one-foot intervals on the pole and mark them with a pencil. Wrap red tape around each mark and make certain the ends of the pole have tape around them as well. With a grease pencil, label each mark, starting with #1 at the point which is one foot up from the ground, then #2, two feet from the ground, and so forth.

Divide the one-foot intervals into thirds and mark these division points with the grease pencil. (See Fig. 1.) If the hill chosen for study is overgrown with vegetation, you might consider painting the range pole white prior to marking the gradations, to make spotting easier.

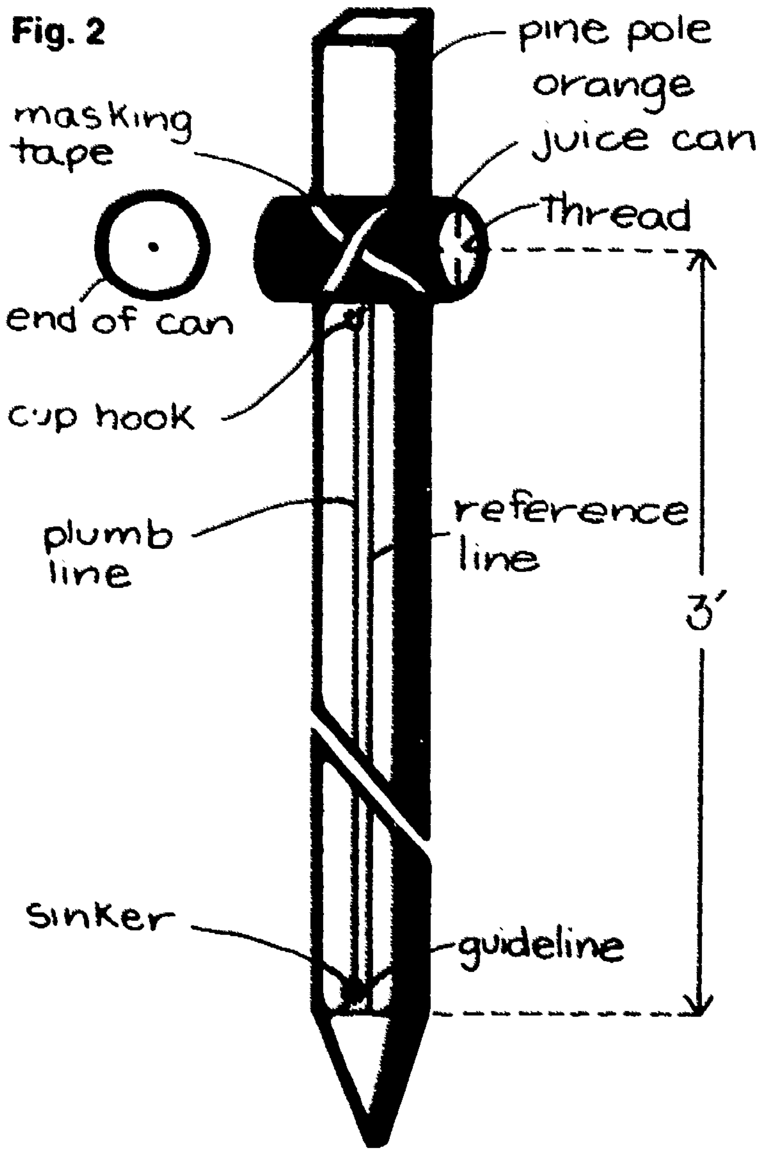
Fig. 1



II. Sighting Device ("Transit")

Before attaching materials to the pole (refer to following illustration) the pole should be pointed at one end like a stake, so that it may be driven into the ground up to the **guideline.** The guideline is a mark near the bottom of the pole, perpendicular to the length of the pole, up to which the pole will be driven into the ground. This guideline insures that the height from the ground up to the cross hairs is exactly three feet. With a grease pencil, draw a vertical line or **reference line** down the middle of one of the 2" surfaces of the pole. (The line should be parallel with the lengthwise edges of the pole.) See Fig. 2.

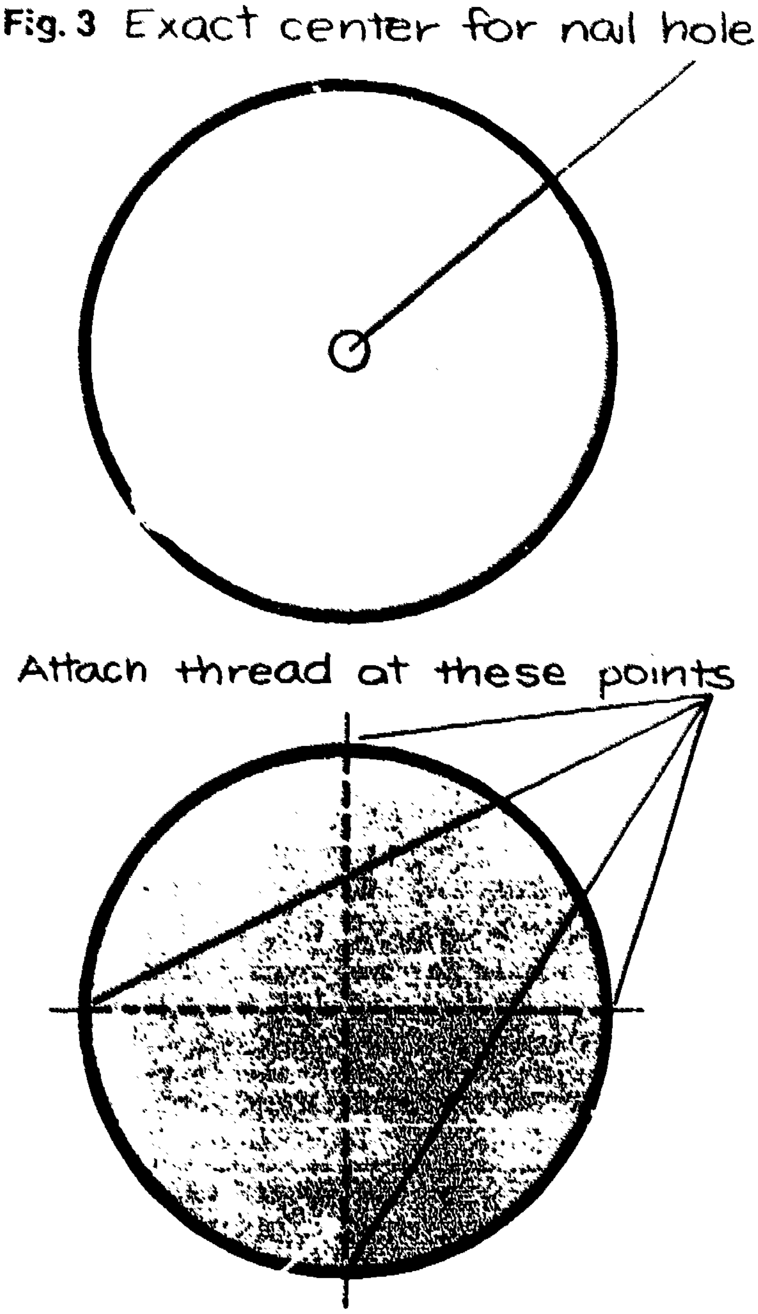
Fig. 2



Trace the following patterns and make a copy for each team. One pattern shows where to put the nail hole on the closed end of the can. The other can be held at the open end of the can to locate the attachment points for the cross hairs. See Fig. 2.

The orange juice cans are to be used for the improvised **sighting device.** With a nail, punch a hole in the middle of the unopened end. Four small holes are punched around the edge of the other end so that two lengths of thread can be strung through the holes, dividing the open end into four equal quarters (See Fig. 3). Draw threads through the holes and fasten them to the can with masking tape.

Fig. 3



Use a nail to start a hole in the **pine pole** about a foot down from the top end, on the reference line. Screw the small **cup hook** into that hole. Attach the **sinker** to the **thread** and tie the thread to the cup hook. A ***leveling device*** is thus formed. When the pole is upright, the plumb or thread should line up with the reference line of the sighting device pole.

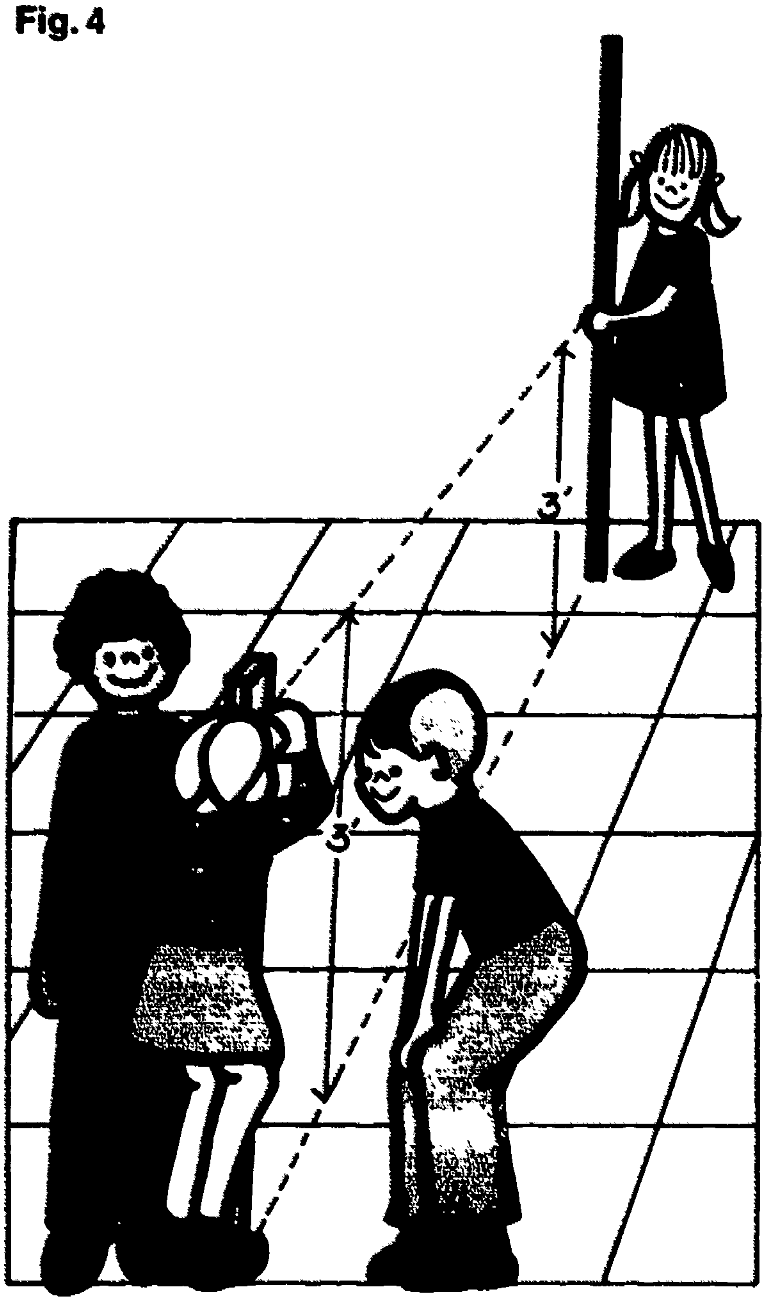
Attach the orange juice can tightly above the cup hook by wrapping it to the pole with masking tape. The can should be positioned as close as possible to a right angle to the pole. The distance between the **center** of the juice can (where the cross hairs meet) and the **guideline** at the base of the pole should be exactly *three feet.*

Each sighting device should be finely adjusted so that the can is at right angles to the sighting device pole. This can be accomplished indoors in the following manner:

1. Measure the height from the point on the end of the sighting pole to the middle of the can. This distance will probably vary slightly from one device to another but should measure a little over three feet.

2. Measure off the same height on the range pole.
3. Place a small mark on the range pole to indicate the point equal in height to the center of the can. (This is a temporary mark for adjustment only and will not be used in any subsequent sections.)
4. Now, place the range pole against one wall, perpendicular to the floor. Several feet away locate the sighting device. Hold the sighting device pole so that it is plumb (i.e., the weighted string lines up exactly with the lengthwise reference line drawn on the sighting device pole.)
5. Sight through the hole in the juice can toward the range pole lining up the point where the threads cross, with the mark of equal height on the range pole. It will probably be necessary to move the can slightly for fine adjustment. Once the device is lined up in this way, you may want to add some more tape to secure the can in the correct position. With these adjustments, the can should be in a position perpendicular to the sighting device pole and ready for the contour mapping activities. See Figure 4.

Fig. 4



III. Stakes

Any piece of scrapwood will do, although a 1"x1"x8" size is preferable. One end of each piece may be shaped to a point so that the stake can be easily pushed in the ground or driven with a hammer. The tops of the stakes may be wrapped with tape so that they are easily seen in tall grass.

IV. Rope

Measure 1-foot intervals along the length of the rope and mark them with red tape.

Practicing

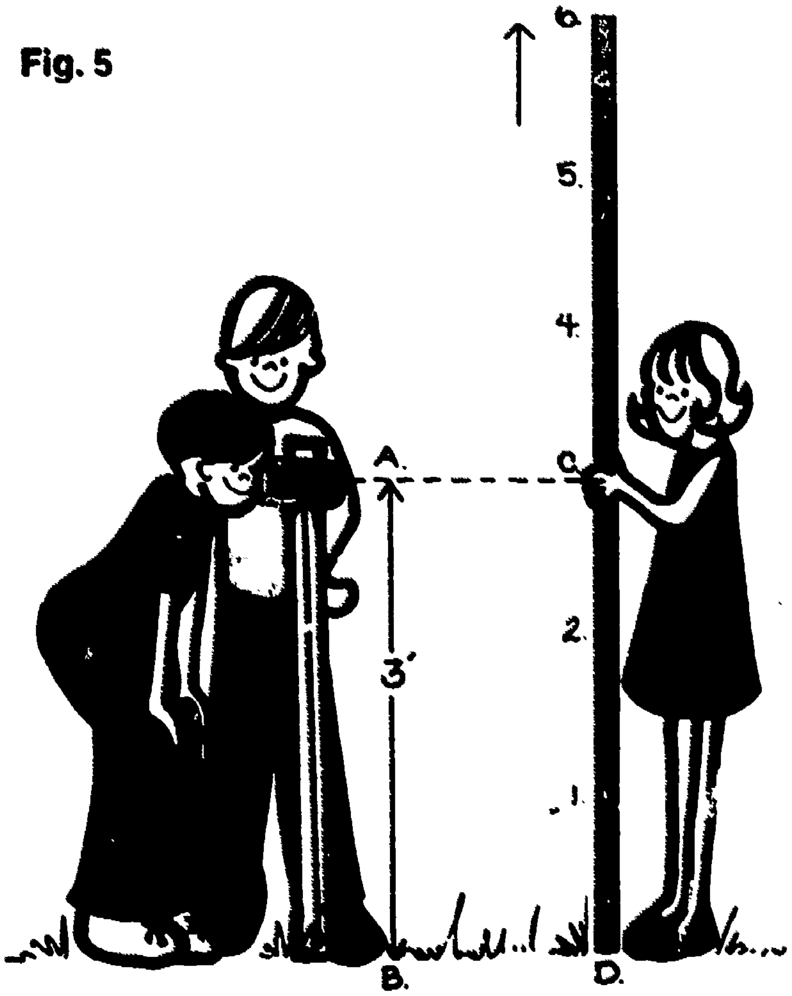
Once the equipment is built, the students should spend time practicing its use. The class could practice using the equipment indoors, but outdoors on the schoolground is probably better because of the greater space available.

When the students first built the equipment, they discovered that the juice can with its crossed threads could be used as a sighter. They will now practice the technique of spotting something through this sighter, by viewing through the hole in the can to where the threads cross, and lining up that point with one of the marks on the range pole.

Make sure the students realize that all sighting must be done with the sighting device in a **vertical**, or **plumb** position. They will know that this is the case when the thread line hangs straight down the reference line which has been marked on the pole.

Divide the class into groups or teams of three students each. Each group should have a sighting device, range pole and rope. One student will handle the range pole, another the sighting device, while the third has the responsibility for seeing that the sighting device is vertical. Position each group along a line somewhere in a level grassy area of the schoolyard. Direct the individuals with range poles to place them several feet away from the students with sighting devices. Have the sighter drive his pole into the ground down to the guideline. The third member of the group should determine when the thread drops straight along the reference line, indicating that the sighting device is level. Once the device is level, the student doing the sighting should view the range pole through the juice can. The person holding the range pole should move his hand upon the pole until the sighter can see his hand at the point where the cross hairs intersect. The range pole holder can check the distance from his hand to the ground by looking at the scale of marks on the range pole. Ask: What is this distance? See Fig. 5.

Fig. 5



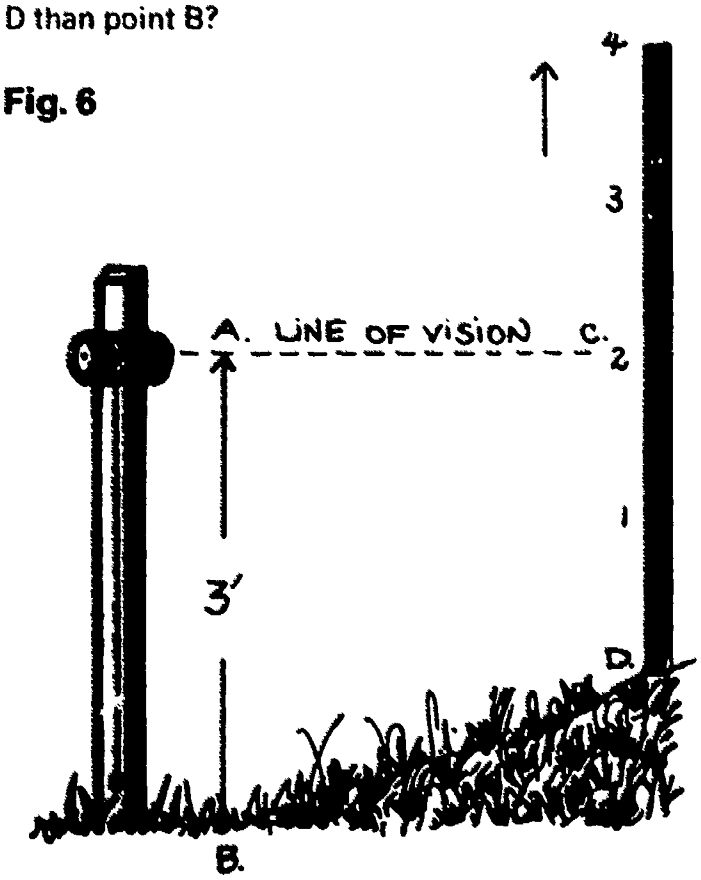
The students should discover the relationship between CD, the distance from the point at which their **line of vision** hits the range pole to the ground, and AB, the distance from the crossed threads on the juice can to the ground. In other words, if the sighting device and the range pole are on points of **equivalent elevation**, the distance from the sighted point on the range pole to the ground should equal the distance from crossed threads on the sighting device to the ground. It may not be easy for the students to see this relationship at first. Have the third student measure those two distances (AB and CD) with his rope. The figures should be reported to the other members of the group. Have the groups continue practicing and sighting with each group member, in turn, using the different pieces of equipment.

When each of the students in a group has had an opportunity to familiarize himself with the equipment on level ground, have that group move to an area where a slight slope exists. The aim here is to have the students observe what occurs when the range pole is placed at a point higher than the sighting device.

In carrying out this activity, have each person with a range pole stand on an elevated spot while the sighter fixes his eye on the pole. The ground on which each range pole rests should not be more than three feet higher than the ground on which the respective sighting pole rests. (If no slope is to be found on your school grounds, the range poles can be elevated by putting them on steps or other raised objects.) The pole holder should now move his hand upon the pole until it intersects with the sighter's line of vision. Have the person using the pole read the distance from his hand to the base of the pole (CD). See Figure 6.

Ask: How does this distance compare with the distance measured when both the sighting device and range pole were on the same elevation? What does the difference mean in terms of the elevation of the person holding the range pole; in relation to the elevation of the sighter? How much higher is point D than point B?

Fig. 6



The students should begin to understand that distances AB and CD will be **equal** when the range pole is at the same elevation as the sighting device, and that the distances AB and CD will be **different** when the range pole is not at the same elevation as the sighting device. This is because the location of point C varies along the range pole, but points A, B and D are fixed. Distance AB never changes.

If there is much variation in elevation on the schoolgrounds, the students might locate spots of several arbitrary elevations in relation to some known point on the schoolgrounds. For example, they might find spots that are one foot higher, two feet higher, and three feet higher than the front door of the school.

Once the students have had sufficient experience with the equipment to discover some of the relationships between distances discussed in the preceding paragraphs, it may be helpful to draw Fig. 6 on the board for them. This will help them visualize the geometry involved in the activity.

Perhaps the students have discovered for themselves that distance CD is always smaller than AB if the spot of ground on which the range pole is placed is at a higher elevation than the ground on which the sighting pole rests. (See Fig. 6.) Ask: Under what circumstances would CD be larger than AB? How could these circumstances be created? Give students the opportunity to work with the equipment to discover how to set up this new situation. Perhaps they could locate spots two feet lower, or three feet lower than the front door of the school building.

Allow enough time for the students to experiment and understand the workings of their devices before they begin their field work. The amount of time needed to become familiar with the equipment will depend upon the age and ability of your students.

Making the Class Contour Map

The Figures used in this section will be found in the back of the book, beginning on page 14.

I. Slope Identification

When the members of the class are ready to begin the field work, the first thing they will need to do is identify the hill they will use for making their contour map. It would be good if the slope were near school. Have them examine park areas within walking distance. Persons owning property might give permission for students to use their land for contour mapping activities.

The criteria for choosing a hilly area should include its accessibility, size, and angle of slope. The area should be large enough so that teams are not in one another's way. The activities will work especially well if the length of the hill extends for about 200 to 400 feet. The slope should be steep enough to produce significant results but it should not be difficult to ascend.

Many schools will not have a "good" hill within walking distance. In this event, explore the possibility of field trips so that the class can still participate in the important field activities of the unit.

The amount of time needed for the field work will be related to the amount of organization done before the trip. (The pages which follow present a detailed, step-by-step outline of the procedures which each team will have to use in making the class contour map, once they have arrived at the field site. At this point, it is strongly recommended that you read these instructions carefully, then while still in the classroom, explain to the students exactly how they will go about making the contour map.)

II. Begin the Contour Map With the Zero Line

The first thing that must be done is to set up a **zero line.** The zero line is simply a straight line running along the base of the hill. The students will use the zero line as a reference from which they will establish the **contour lines** that make up **contour maps.**

When you locate the hill, place one stake in the ground at the base of the slope, before the area where the rise in elevation begins. Stand at the stake (you can have one of the students do this if you like), hold the compass in your hand and face along the base of the hill in a north-south or an east-west direction. Any compass direction will be satisfactory, but if the original orientation is north-south or east-west, the activities that follow will be easier for the students to handle. For purposes of explanation, we have assumed, in the sections which follow, that the direction along the base of the hill is **north-south.** See Figure 7.

Using one of the sighting devices, sight along the base of the hill in the north-south direction. Have a student walk along this line to a specified distance (200-400 feet would work well), and drive a second stake in the ground, on the line. This north-south line is the **zero line.**

III. Mapping the First Contour Line

The next step will be to lay out the **first contour line.** This contour line will be established up the hill a short distance from the zero line. All points on this first contour line will be at the same elevation. Steps for establishing the first contour line follow. Again, break the class into teams of three students each. One student in each team will work the sighter, another will be responsible for making sure it is level or plumb when measurements are being taken, and the third will work the range pole.

Step one. Identify each team with a letter. Station all the teams and their equipment along the zero line, an **equal** distance apart. The exact distance is arbitrary. It will depend partly on the size of your hill. Have each team drive a stake into the ground at its location on the zero line.

Step two. Have all the teams direct their sighting devices toward the hill in an east-west direction *(perpendicular to the zero line).* Next, have each team send one of its members out toward the hill (the team member who does not have a piece of equipment to manipulate would be a likely candidate), along that team's east west line, to drive a stake into the ground. The aim here is to establish a point toward which each team will work. It does not matter how far away each stake is placed as long as it can be seen clearly. On the other hand, a stake should not be outside the limits of the area you plan to map. Depending on the size of the hill, some of the teams will be sighting up a steep incline while others may be sighting along only slightly raised ground. When these east-west sightings have been made, you will have a north-south zero line with east-west lines coming off the zero line. The east-west lines will all be perpendicular to the zero line and parallel to each other. See Figure 8.

The next several steps will take a short time to complete and will need to be done by pairs of teams. The teams farther away from team A will be delayed for a brief time. During this interval, they can practice using their sighting devices.

Step three. Have team A and team B go out a few feet along their east-west lines. Have team A locate a spot for its sighting device on its east-west line by driving a stake in the ground at an *arbitrary* point chosen on its line. Next, with its sighting device driven into the ground next to its stake (it should be loose enough so it will swivel slightly), have team A point its sighter in the general direction of team B. Another member of team A will need to check that the string with the sinker lines up along the guideline of his team's sighting device pole. Have team B's range pole man place his hand on the three foot mark of his range pole and move the pole along his team's east-west line until team A's sighter can see the hand on team B's range pole at the 3-foot mark through his sighter. Once the sighting has been made in this manner, it will mean that team B is on the same elevation as team A. Have team B drive a stake in the ground at that point of equal elevation with team A. See Figure 9.

Step four. Next, the students need to locate a third point, point C, that is at the same elevation as points A and B. Point C can be determined by the members of teams B and C following the same procedure outlined in step three, except that this time, team B will use the stake it has just located as the point next to which it drives its sighting device. Continue locating points D,E,F,G,H, etc. around one side of the hill until the students have located a point for each team. When this has been done, each team will have a point marked by a stake. All of the stakes will be at the **same** elevation. All stakes will be on the **first** contour line.

Step five. Now each team should measure the horizontal distance from its stake on the contour line to its stake at the zero line. To measure horizontal distance, one student can put the sighting device next to his team's stake at the zero line and another student can hold the range pole at his team's first contour point. After making sure that the sighting device is vertical (by lining up the weighted string with the line on the sighting pole), each team should have one member look through his team's sighting device at his team's range pole and read the number viewed there. By extending the measured rope from the sighting device cross hairs to the number viewed on the range pole, they will get the horizontal distance from the zero line to the first contour point.

Step six. Have each team make a sketch of the general area to be mapped. The zero line, with all of the stakes labeled according to each team's letter, can be drawn across the bottom of the page. Have each team indicate all the points on the first contour.

The contour points should be shown in their relative positions according to the distance of each to the zero line.

Step seven. On the drawings, have each team connect all of the first contour points with a curved line. Explain to the students that the line has to be drawn so that **any** point on the line (not just those which the teams have located) will be at the same elevation. Drawing the line will, of course, involve some estimating on the part of the students (see Figure 10). You might help your students understand more clearly what they are doing by explaining that if you took a giant cutting edge and sliced the top of the hill off perfectly level through the contour points that have been plotted, then **all** of the points on the rim of the cut would be at the same elevation. You might also explain, at this time, that ***one contour line will never cross another***. This fact will become especially important later in the unit when the students bring their information together to make a class contour or topographical map of the hill. See Figure 11.

IV. Mapping Up the Hill

Now that each team has established its first contour point, each will work its way up the hill establishing subsequent contour points.

All of a team's contour points will be located on that team's east-west line. In order to stay on its east-west line—that is, on the line perpendicular to the zero line—each team can sight toward the stake that it has driven in the ground up the hill. After a team reaches its stake, it will have to take another sighting in order to extend its east-west line. This will be especially necessary at the top of the hill when the teams start going down the other side.

Before proceeding with their contour mapping, the students should choose a fixed **contour interval.** In other words, all teams should decide how many feet in elevation they will have between one contour line and another. (In terms of an individual team, between one contour point and the next one, up or down the hill.) All teams will have to use the same interval. A question will probably arise concerning the size of the contour interval—that is, whether each contour line should represent 1', 2', or 3' change in elevation. Look at Figure 12. In this case, the sighter looks through the sighting device and takes a reading on the range pole. Point C is one foot above the ground level. Since the sighting pole AB is three feet tall, point D is two feet higher than point B. Thus, the contour interval between B and D is two feet. Readings could be taken at the 0 mark on the range pole, but sometimes in the contour activities weeds and grasses obscure the end of the range pole, making sighting difficult.

A two-foot contour interval will probably be adequate for the students. Once a convenient interval is chosen, it could be indicated on each range pole with tape of another color. Thus, if the students decide to make their sightings at the *one foot mark* (i.e., a two foot contour interval) the one foot mark could be made to stand out by wrapping black tape around the upper and lower margins of the red tape at the one foot mark on the range pole. For convenience, the size of the contour interval should be determined by factors such as the size of the children, the steepness of the slope and the time available—a larger interval means fewer sightings and less time.

To begin the actual surveying, each team sighter places his device at his team's designated first contour line stake. He then directs the range pole man to move up the hill slowly on the straight east-west line, until he can view, through his sighting device, the fixed sighting mark (black tape) on the range pole. The third member of the group should see that the sighting device is vertical by checking the weighted string and reference line. When the pole man is standing at the proper elevation, (i.e., when he is standing at a point two feet higher than the student with the sighting device, assuming you are using a two foot contour interval), a stake should be driven into the ground at that point. This stake should be lined up with (1) the stake on the zero line, (2) the stake at the first contour line, and (3) the reference stake previously placed up the hill (See Figure 13). Have the team measure the *horizontal distance* of this contour interval with the marked rope. The measured distance runs from the cross hairs of the sighting device to the fixed sighting mark on the range pole. Make sure the students do not measure along the ground surface. Each team should record all of its own horizontal distances on its own sketch.

After each group has completed this procedure, the student who is sighting will move up the hill to the newly placed stake and repeat the procedure. The remainder of the work is merely a repetition of sighting, staking, measuring, and recording until the top of the hill is reached. Each team should include on its sketch: (1) cumulative elevation of each contour point above the first contour line, and (2) horizontal distance between successive contour points.

As each team proceeds up the hill, it will find that the measured horizontal distance between contour points will vary according to the steepness of the hill. See Figure 13.

While it is not necessary to use stakes, they are an aid in determining whether a team is moving in a straight line. In the event that teams do not have a sufficient number of stakes, the pole holder can stay in position until the sighter moves the equipment to that point, or some of the earlier stakes can be re-used.

At some time, perhaps after the third stake has been placed, direct the teams to notice their position in relation to one another. Are all the teams at the same point of elevation? Some of the teams will reach the top before others. These groups may wish to review their data or discuss some of the problems which developed as they worked up the hill.

If the hill was wooded and their line would have gone *through* a tree, how did they deal with this situation? Did anyone go through a gully area to find the range pole lower than the sighting device?

V. Mapping Down the Hill

When the entire class has reached the top of the hill, ask if they can repeat the process if they were to go down the other side of the hill. In other words, can contours be determined starting at the top and working down the slope? If so, how could it be done?

As one proceeds down the hill, the sighting technique is somewhat different than when going up. Another *fixed* sighting mark on the range pole must be used in this instance. The sighter must select a mark *higher* on the range pole and aim at that mark as the team *descends* the hill. (See Fig. 14.) The mark chosen is determined by the size of the contour interval. If it were two feet going up the hill, it has to be two feet going down, otherwise the contour map will not be accurate. This time the sighter's point will be *above* the point he would ordinarily sight if both range pole and sighting device were level with one another.

In Fig. 14, a two-foot contour interval is maintained by sighting at the five-foot mark on the range pole. (Remember, the sighting device is three feet high.) If the class has used a three-foot contour interval, ask what mark they would sight on the range pole? Again it would be helpful if the fixed sighting point on the range pole were clearly marked. Black friction tape could be wrapped around the pole at the chosen point to make it stand out from the other marks. The class may now work their way down the hill sighting and recording elevations and distances.

Remind the students that as they go down the hill, they will have to stay on their same east-west lines that they used coming up the hill. A good way to assure this is to have a member of each team stand at the top of the hill on its east-west line and sight down to the bottom of the side they now plan to map, again in an east-west direction. At the bottom of the hill, have each team drive a stake into the ground to use as a guide. Each team will also want to take periodic compass readings as they go down the hill as a check on their direction.

VI. Recording Data

Below is a sample chart indicating how records might be organized. The data will be used after the completion of the activity, when a class **contour map** or individual contour maps of the area are made. Each team should keep similar records. See Figure 15 for a larger chart that can be duplicated and given to the students.

Distance of 1st Contour Point from Zero Line			
Contour Interval	Stake No.	Accumulated Elevation	Horizontal Distance
2	0D	0	7'
2	2D	2	10'
2	4D	4	4'
2	6D	6	9'
2	8D	8	15'
2	8D	8	8'
2	6D	6	4'
2	4D	4	9'
2	2D	2	5'
2	0D	0	

Organizing the Data

The data should be organized either back in the classroom or on a large flat surface in an enclosed area at the site. Have prepared graph paper on which the **contour map** will be drawn. The larger the paper, both in grid size and outside dimensions, the better. Estimate the distance from the zero line, over the hill, to the contour points at the base of the other side. Tape enough graph paper together to allow for mapping this large area. You will have to consider a map scale in which a certain number of **horizontal** feet are represented by one square on the graph. Remember, the squares on the graph must represent **horizontal** distances and not distance along the ground or elevation.

Each team can now proceed to plot the location of all of its points on the large map, in relation to the zero line. The zero line can be the bottom of the graph paper. As each team plots a point, have them designate the **cumulative** elevation and team letter, (i.e., 0A, 2A, 4A, 6A, 8A, etc., if the contour interval chosen were two feet). Note that as a team goes up one side of the hill, it will have one set of elevations. Some of these elevations will be repeated as the team goes down the other side. When all of the points of all teams have been plotted, have the students connect all zero elevation points, all 2 foot elevation points, all 4 foot elevation points, etc.

Before drawing in the contour lines, you might remind the students of two important considerations. First, no contour line will cross another contour line. Secondly, the students should keep in mind that they only know for certain the elevation of those points which they have plotted; therefore, they will have to **estimate** what the contour line will look like between points. Look for a moment at Figure 16, page 19. This shows the type of contour map which a class might draw. As can be seen, team A has plotted only two points, 0A and 0A. Both of these are at the same elevation. Theoretically, these two points could be connected by a straight line. However, by looking at the general appearance of the foot of the hill, the students will probably find that the two points are on a gentle curve of the hill. The arced line between the two points is intended to reflect the curved appearance of the hill at the 0A elevation. Subsequent lines such as those between 2B and 2B and 4C and 4C are also estimates, based on the appearance of the hill as well as the trend that has been established in the preceding line. The lines such as those running from 6J to 6I to 6H and from 8J to 8I to 8H are slightly more complicated, but again they are simply drawn to reflect the contours of the land.

Figure 16 shows the kind of map the children might make. On the map, the space between each contour line represents horizontal distance. Some of the lines are closer together than others. For example, the horizontal distance between the 2G and 4G is greater than the distance between 8G and 10G. Since the contour interval or elevation is **constant** between contour lines and points on those contour lines, we can interpret from the map that the slope between 2G and 4G is *not as steep* as the slope between 8G and 10G. Looking at the situation from another point of view, if you walk up the hill from 2G to 4G and then from 8G to 10G, you will, in both cases, go up two feet in elevation. The horizontal distance between 2G and 4G, however, is greater than the horizontal distance between 8G and 10G.

Discussion will help the students focus upon the more important aspects of the activity. Questions which you might pose to the class for consideration are:

1. What was the difference in elevation between the first stake and the zero line?
2. What was the horizontal difference in elevation between the second stake and the first stake?
3. Was the horizontal distance between stakes always the same?
4. If not, why were there differences?
5. Of what importance is the zero line?
6. Did everyone get the same data? Why not?
7. Could sighting devices be either taller or shorter than those used? How would a shorter device change the data? A taller one?
8. Might similar results be obtained if each group surveyed *around* the hill instead of *up* it?
9. How are the steeper parts of the hill revealed on the map?
10. How are the more gradually sloping parts revealed?
11. How do cuts or gullies appear?
12. How would changing the contour interval change the contour lines?

The children should spend some time now examining both the map and the hill.

If you wish, follow this activity with work on contour maps prepared by the U.S. Geological Survey. You might be able to obtain the map which shows the school area. The class could then be able to identify familiar land features on the map.

Additional Activities

I. Vegetation Sampling

Vegetation sampling was mentioned in the introduction as one possible activity to correlate with contour mapping. If time permits, the class could collect single samples of the vegetation appearing near each stake placed as they worked up the hill and back down. These samples may then be placed on or taped to the contour map to indicate how the plant life changes with elevation. Changes are particularly striking if there is a marsh or pond near the bottom of the hill. Children could correlate available moisture with elevation. In conjunction with this section, you might want to see **Transect Studies,** another unit in this series.

II. Temperature

Temperature of both ground and air may be taken, again at each stake point. This is apt to change as students progress up the hill, and can be yet another factor correlated with changes in elevation and vegetation.

III. Soil Types

Soil types may also vary with elevation. Types may be determined in a relative way by obtaining samples, examining them and comparing them to standard soil type descriptions. (See **Soil,** another unit in this series.)

A variety of other tests can be conducted up the stake line. Relative solar radiation, soil particle size organic content of soil, insect and small mammal population all may be investigated. The data resulting from such investigations can be plotted on the contour map. Eventually, a complete description of the area will emerge. The interrelationship between factors can be discussed; possible explanations for certain observations may be advanced by class members. Additional data may be collected to verify explanations.

FOR DISCUSSION:

When rain falls on a hill, where does it go? On the map, trace the path water would take from the top of the hill. What effect does runoff from this hill have on the surrounding area? Has it caused any erosion? Does the runoff add to the water in a stream or pond? Does it make the soil at the bottom of the hill more moist than at the top?

You might want to progress from an investigation of one hill to that of an area with more contours or different kinds of contours. For example, the class could contour map a large section of a golf course. The map could include several hills, valleys, and standing or running water if possible. Again, the end product should not be a mere map of the area, but rather the aim would be to see how the map could be used to cope with some "real" problems. For example:

- How would a golfer play this area? In which direction would he hit a ball from each tee to reach the next hole with the least number of swings? Where would the ball roll if it landed on certain hills?
- If you were to build a man-made pond, where would you put it? Would dams be necessary?
- If a lake whose deepest point were X feet covered this area, where would the islands be? Where would deep-water fish be found? Where would shallow-water fish be found?
- If you were to build a road through this area, where would it be easiest to build it?
- Plan a farm for this area. Consider such things as contour plowing and where animals should be located to avoid pollution of the water supply.
- Plan a house which could be built on the side of a hill.
- Plan a community for this area. Refer to some of the new community studies which plan with the environment in mind.

The Back of The Book

Figures 7 through 16

Fig. 7 Hill Showing Zero Line

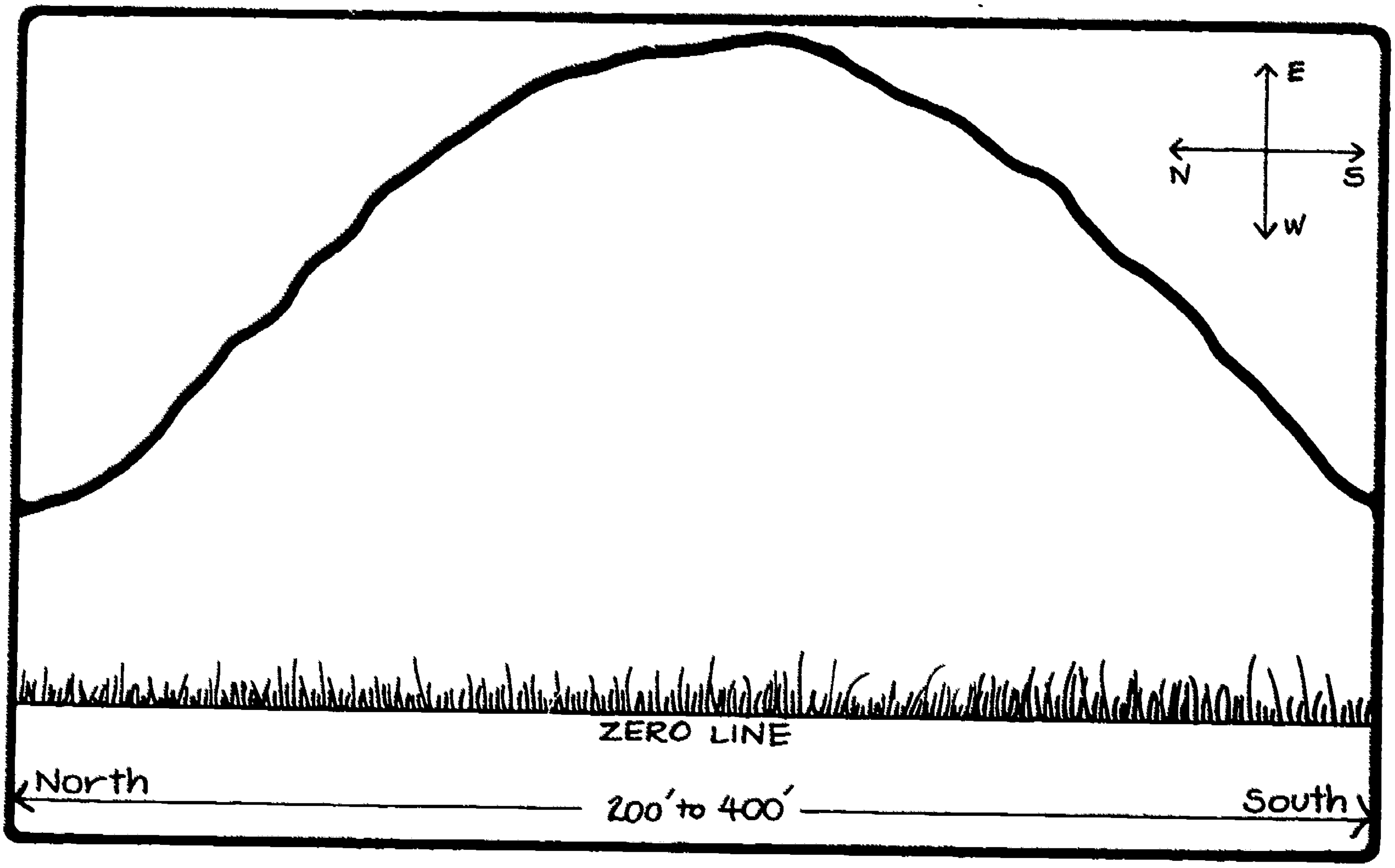


Fig. 8 Hill Showing Zero Line and East-West Lines

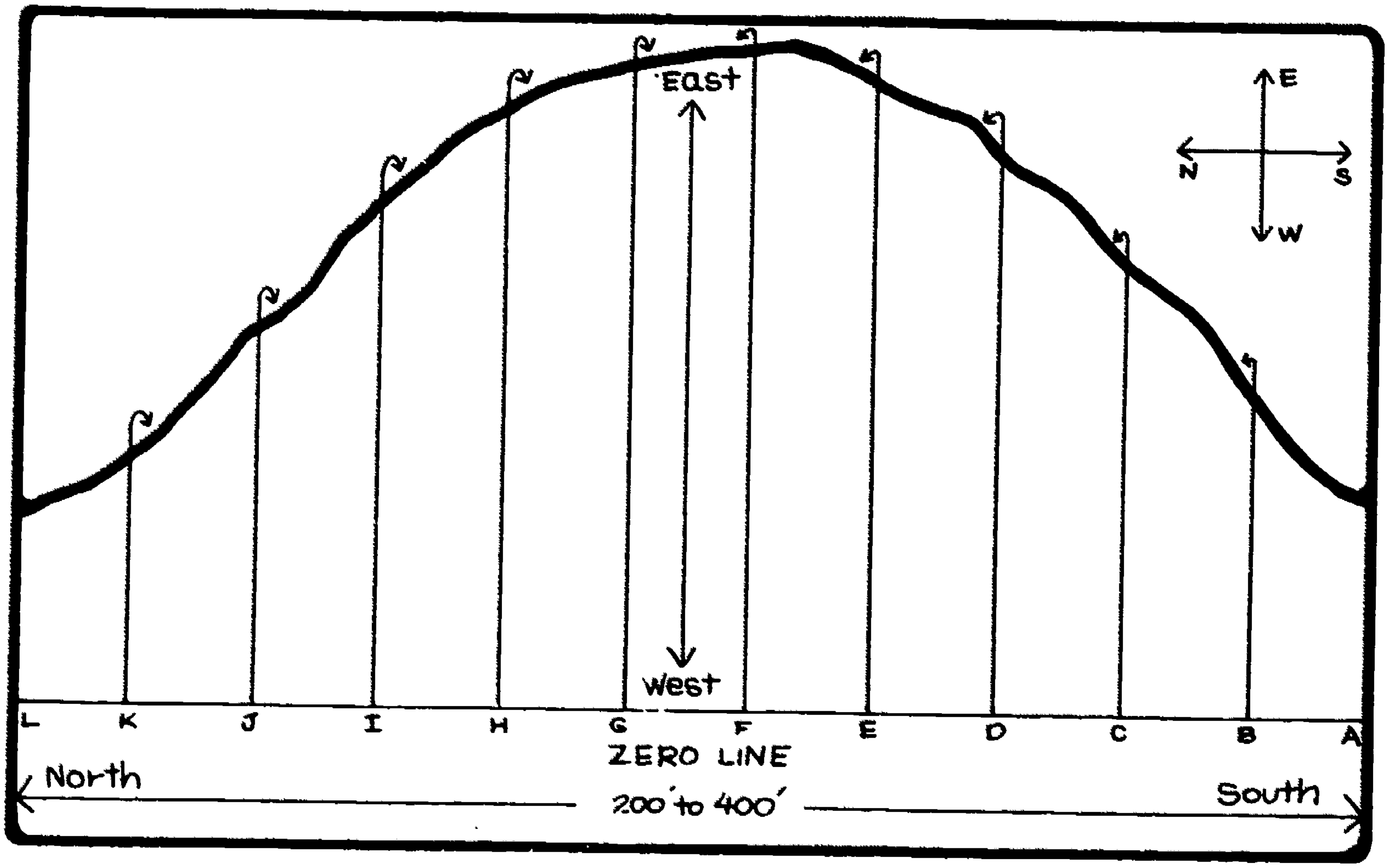


Fig. 9 Teams A and B Establishing First Contour Line Points

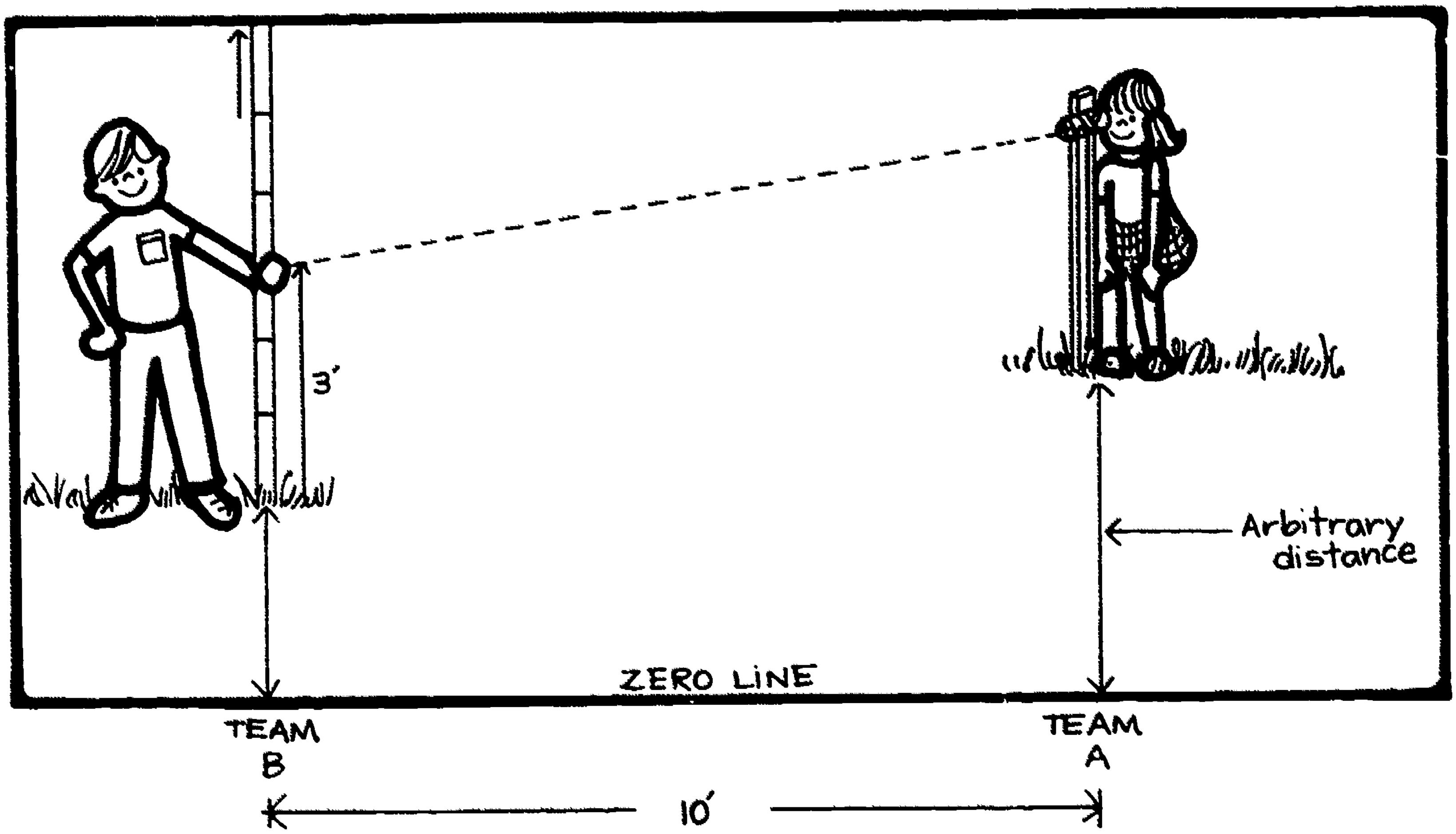


Fig. 10 First Contour Line Points Connected

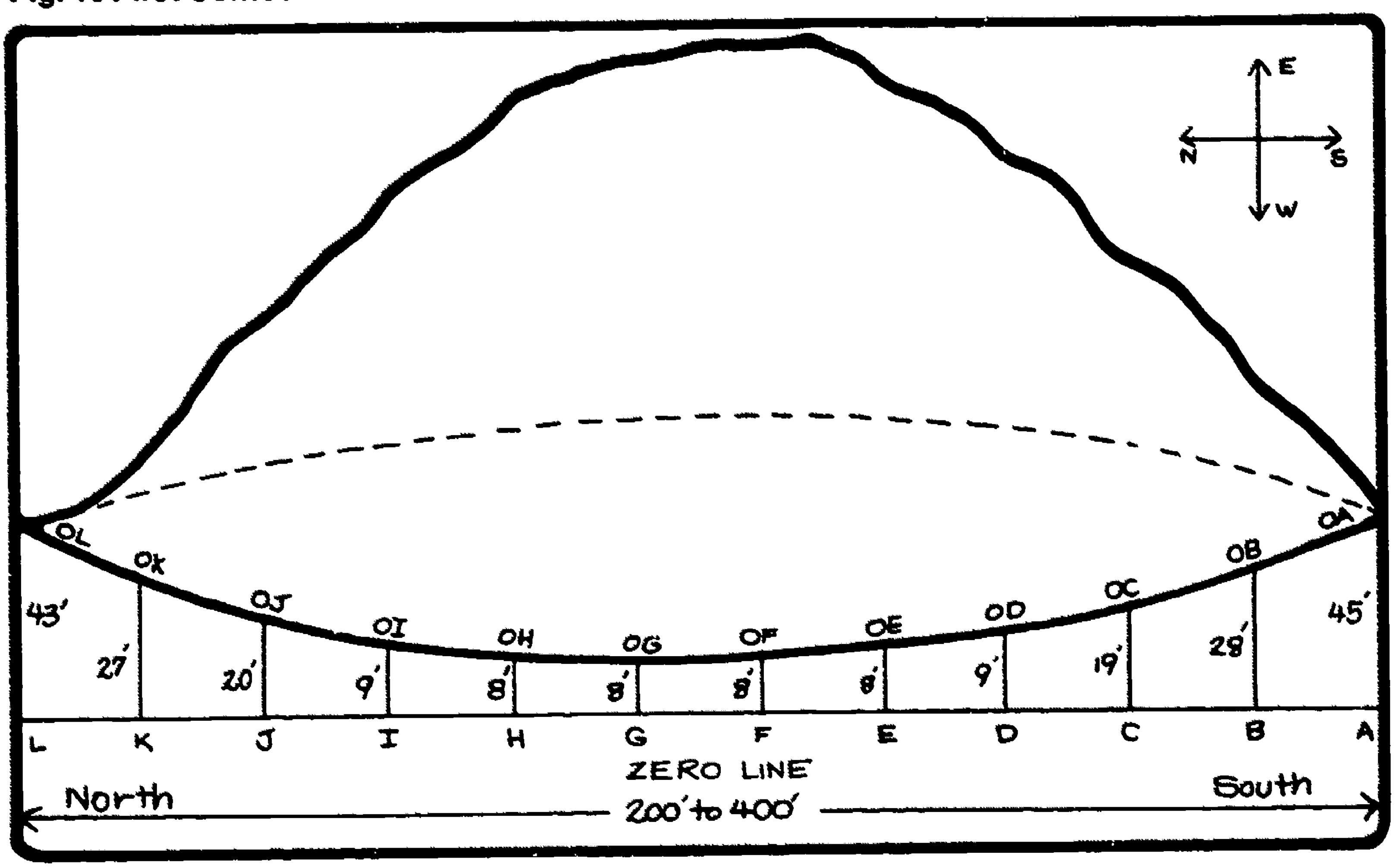


Fig. 11 Hill With Top Sliced Off Level

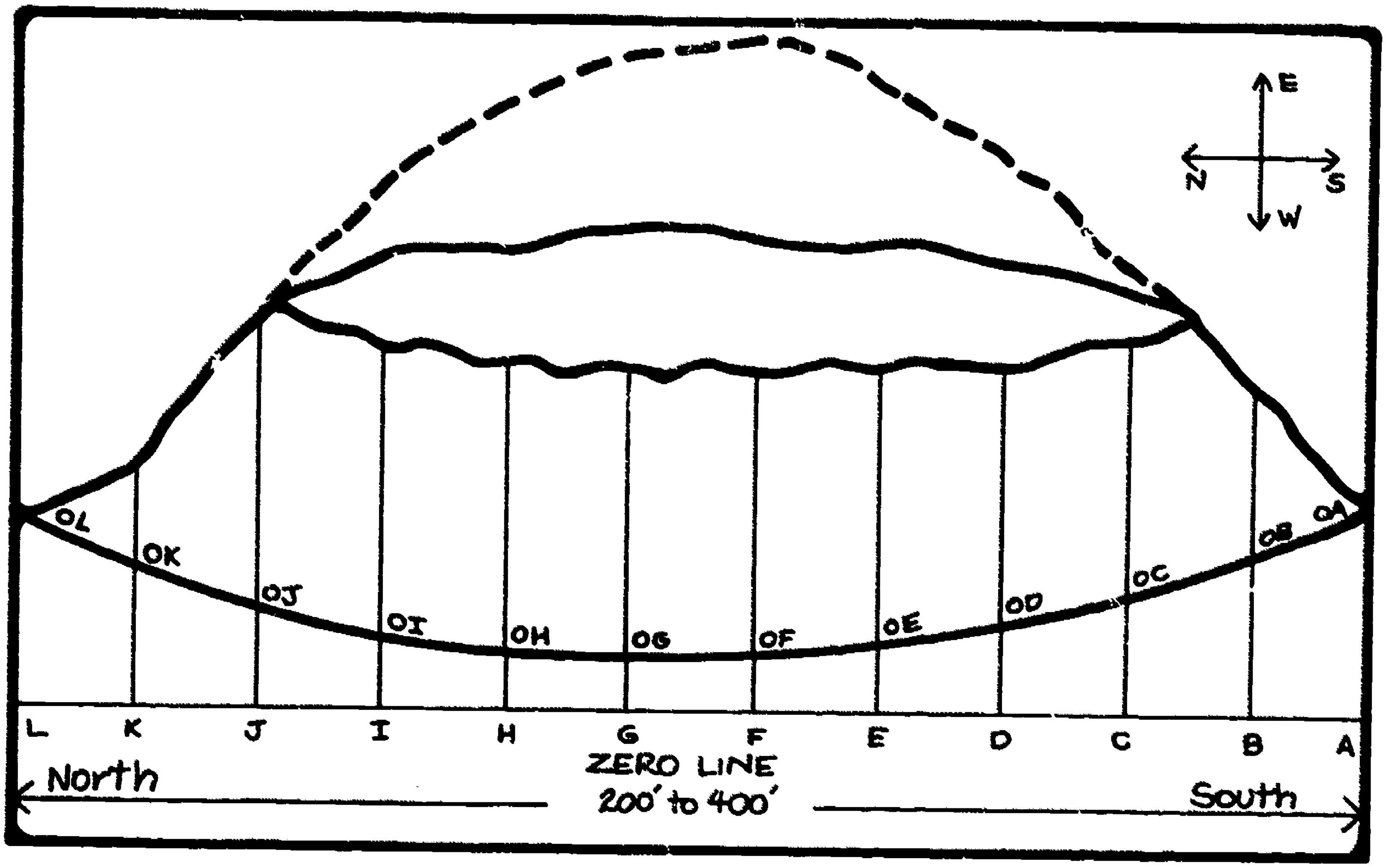
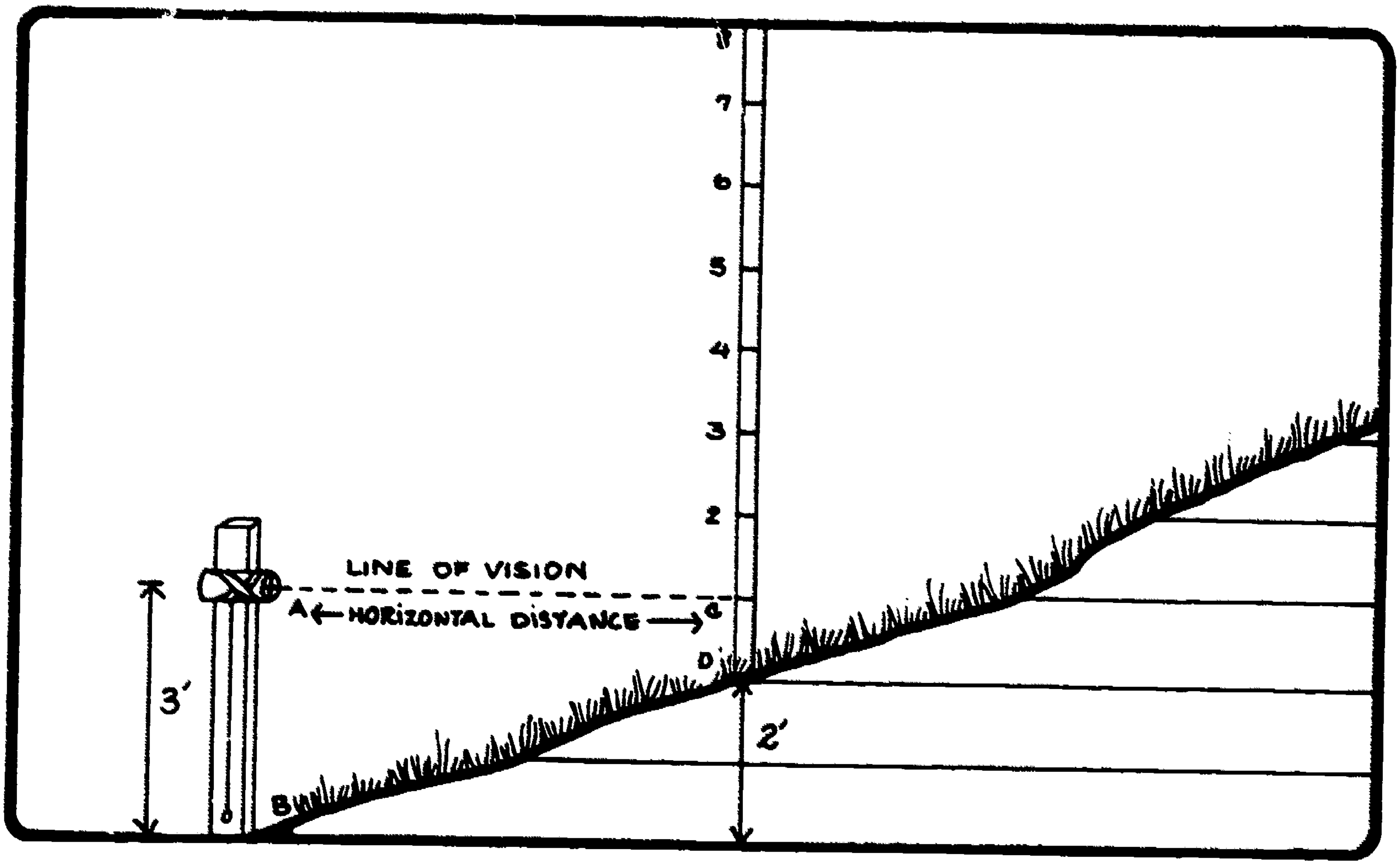


Fig. 12 Two-foot Contour Interval



(Note: In Figures 13 and 14, range pole and sighting device are shown slightly offset for clarity. In practice, as you go up or down the hill, the sighting device will rest on the same spot previously occupied by range pole.)

Fig. 13 Contour Points Up the Hill

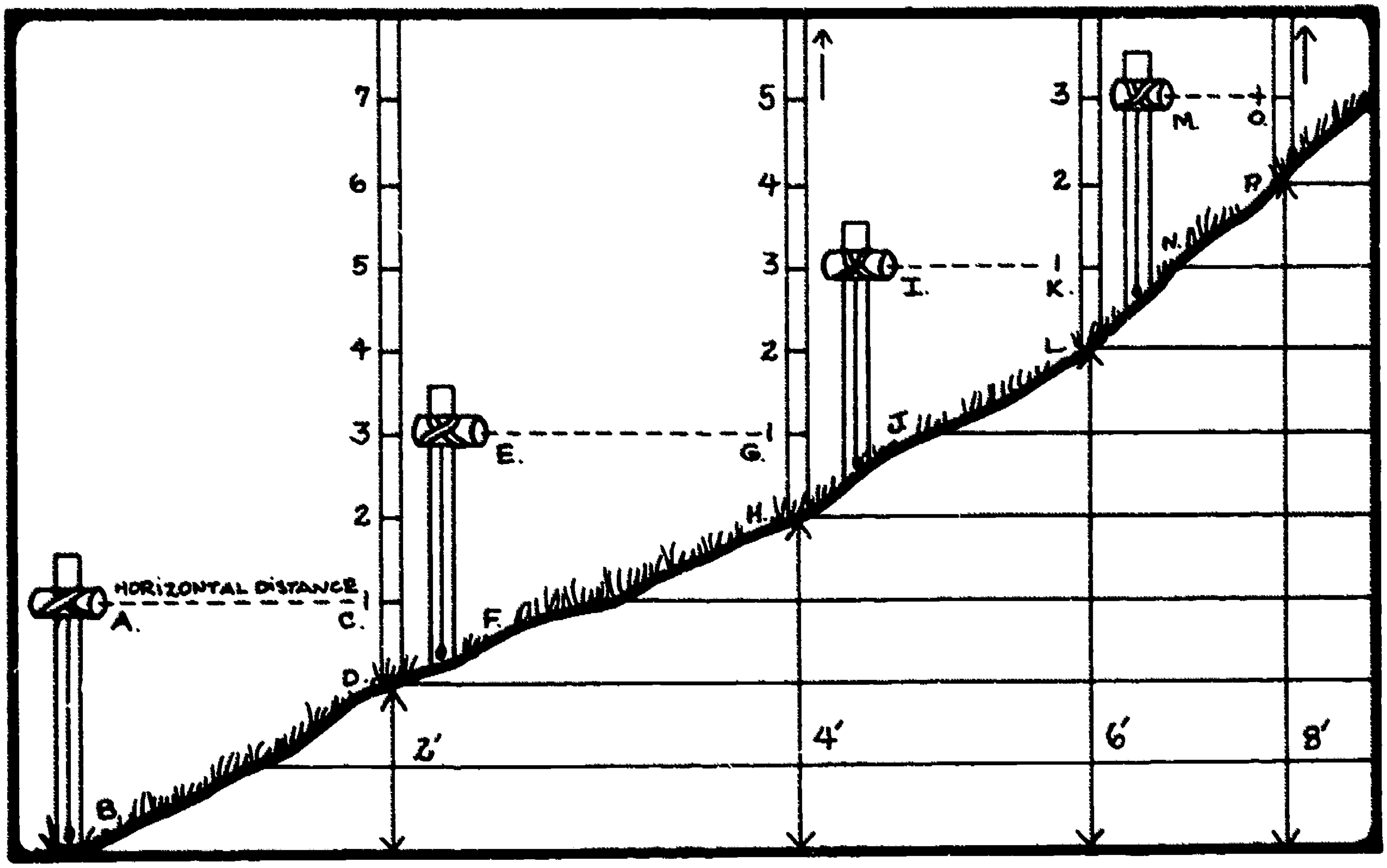


Fig. 14 Contour Points Down the Hill

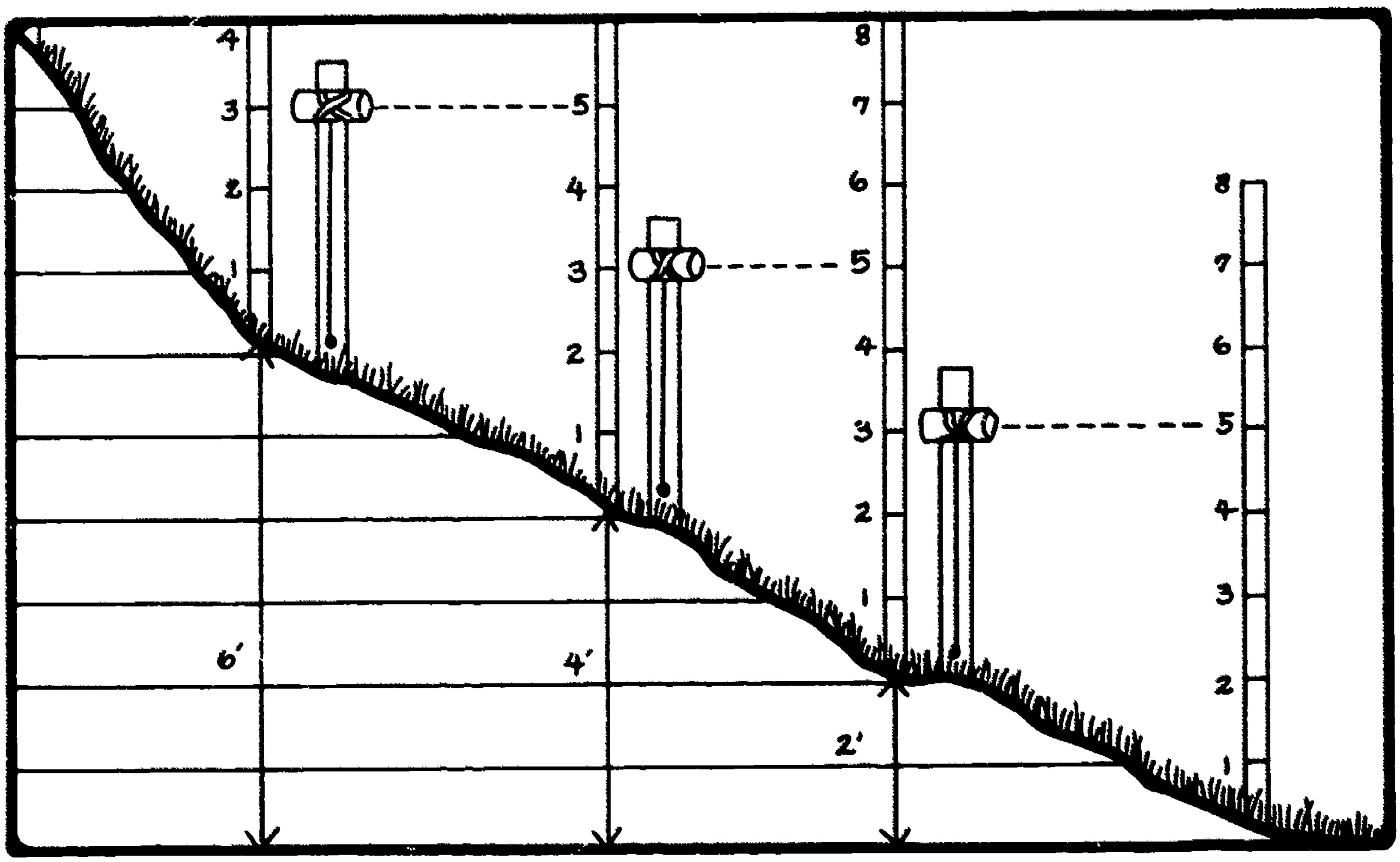


Fig. 15 Data Chart

DATA SHEET			
TEAM			
DISTANCE OF 1ST CONTOUR POINT FROM ZERO LINE			
CONTOUR INTERVAL	STAKE NO.	ACCUMULATED ELEVATION	HORIZONTAL DISTANCE

Fig. 16 Sample Contour Map

THE ENVIRONMENTAL UNITS

Below is a list of the first titles in the Environmental Discovery Series. The ones with order numbers next to them are available as of August, 1972. The others are in preparation and will be available in the coming weeks. Also, ten additional units will be announced soon.

Next to the titles, we have suggested the grades for which each is most appropriate. We emphasize that these are suggested grade levels. The teacher is encouraged to adapt the activities to a wide range of grade levels, and subject areas depending upon the interests and abilities of the students.

Order No.	Title	Grade Level	Price	Order No.	Title	Grade Level	Price
79007	Plants in the Classroom	3-6	$1.50	79123	Genetic Variation	4-9	$1.50
79016	Vacant Lot Studies	5-9	1.50	79132	Soil	2-9	1.50
79025	Differences in Living Things	4-8	1.00	79141	Tile Patterns and Graphs	1-2	1.00
79034	Shadows	1-8	1.00	79150	Plant Puzzles	1-6	1.50
79043	Wind	3-6	1.50	79169	Brine Shrimp and Their Habitat	1-5	1.50
79052	Snow and Ice	1-6	1.50	79178	Nature's Part in Art	3-6	1.50
79061	Man's Habitat—The City	4-9	1.50	79212	Contour Mapping	4-9	1.50
79070	Fish and Water Temperature	4-9	1.50		Change in a Small Ecosystem	5-9	
79089	Oaks, Acorns, Climate and Squirrels	1-6	1.50		Transect Studies	3-9	
79105	Nature Hunt Spec. Ed.	K-1	1.00		Stream Profiles	4-9	
79098	Sampling Button Populations	3-9	1.00		Color and Change	K-2	
79114	The Rise and Fall of a Yeast Community	6-9	1.00		Outdoor Fun for Students	1-12	

If you would like a free brochure describing activities in the individual units, write:

The National Wildlife Federation
Educational Servicing
1412 16th Street, N.W.
Washington, D. C. 20036

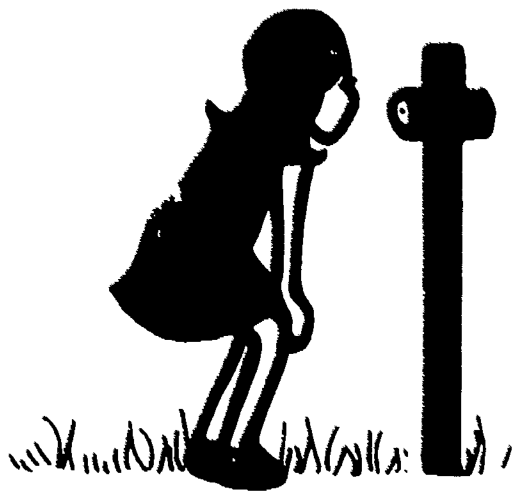
Written and developed by:

NWF

John Cary Stone
James D. Davis
Kathleen DiBlasio
Wendy Kay
B. J. Mitchell
Phil Nicholson
Tom L. Smith

MESF

Edmund Bray
Barbara Clark
Robert Collins
Joann Current
John Heitkamp
David Jones
Karen Jostad
Edward Landin
Richard Myshak
Michael Naylon
Robert O'Hara
Noreen Teachout
Carl Vogt



NATIONAL WILDLIFE FEDERATION
1412 Sixteenth Street, N.W.
Washington, D.C. 20036