1

Contours and Form

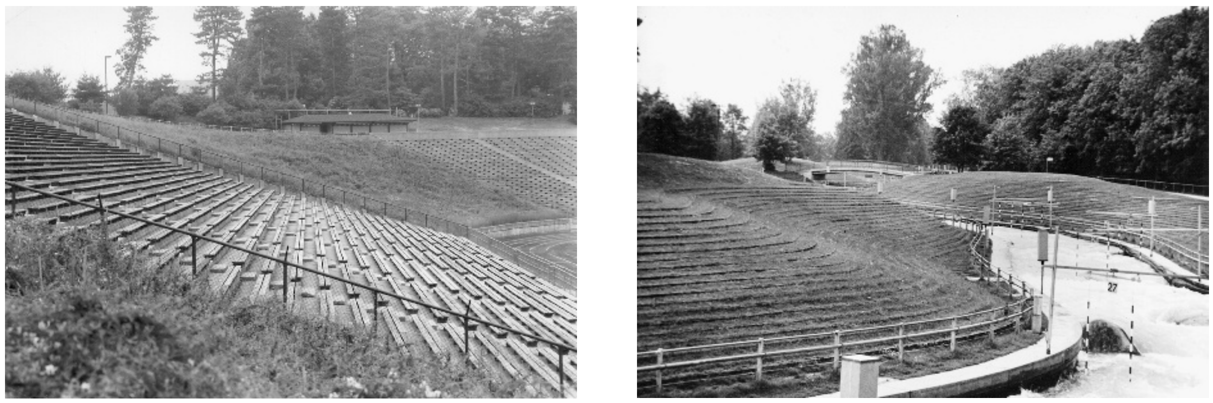
DEFINITION

A clear understanding of what a contour represents is fundamental to the grading process. Technically defined, a *contour* is an imaginary line that connects all points of equal elevation above or below a fixed reference plane or datum. This datum may be mean sea level or a locally established benchmark. A *contour line* is the graphic representation of a contour on a plan or map. Within this text, however, the terms *contour* and *contour line* will be used synonymously.

A difficulty with understanding contours arises from the fact that they are imaginary and, therefore, cannot be easily visualized in the landscape. The shoreline of a pond or lake is the best example of a naturally occurring contour and illustrates the concept of a *closed contour*. A closed contour is one that reconnects with itself. All contours eventually close on themselves, although this may not occur within the boundaries of a particular map or plan.

A single, closed contour may describe a horizontal plane or level surface, again illustrated by a pond or lake. However, more than one contour is required to describe a three-dimensional surface. Rows of seating in an athletic stadium or amphitheater (Figure 1.1) provide an excellent way to visualize a series of contours that defines a bowl-shaped form. It is important to emphasize here that contour drawings are two-dimensional representations of three-dimensional forms. A basic skill that landscape architects and site designers must develop is the ability to analyze, interpret, and visualize landforms from contour maps and plans, commonly referred to as *topographic maps*. Designers must not only understand existing contours and landforms but also the implications of changes, both aesthetically and ecologically, that result from *altering* contours. The series of illustrations in Figures 1.2 and 1.3 demonstrate how contours define form and how a form may be altered by changing contours. The contour plan of the pyramid results in a series of concentric squares. By changing the squares to circles, the form is redefined from a pyramid to a cone. Figure 1.3 illustrates this transformation, starting with the contour plan.

Another aspect of contours and form is illustrated by Figures 1.3 (b and c) and 1.4. A *gradual* rather than abrupt change is assumed to occur between adjacent contours. In Figure 1.4, a section (see definition in following section) has been taken through the center of the cone. (Note that a section taken through the center of the pyramid results in the same two-dimensional form.)



(a) (b)

Figure 1.1. Visualizing contour lines. (a) The stepped levels formed by stadium benches demonstrate the concept of contour lines. (b) Small terraces created for spectators at the site of the 1972 Olympic kayak run provide an excellent example of contour lines as they appear on the ground.

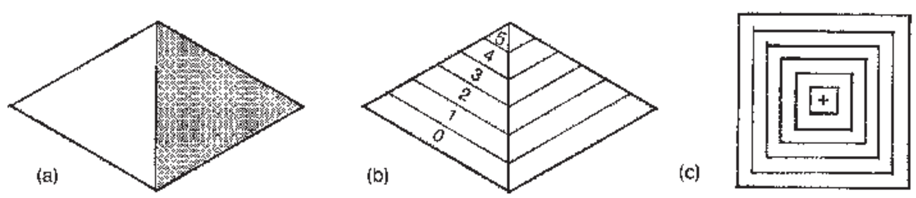


Figure 1.2. Relationship of contour lines to three-dimensional form. (a) Isometric drawing of pyramidal form. (b) Contour lines illustrated on the isometric drawing. (c) Contour plan of pyramid (concentric squares).

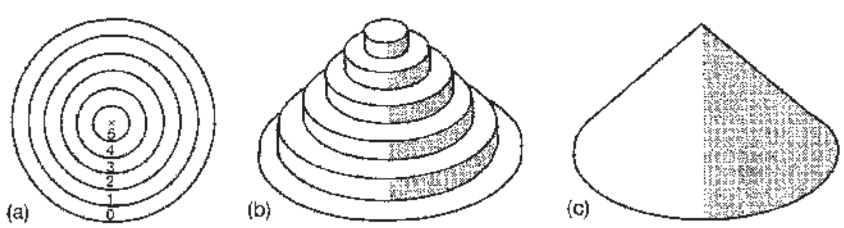


Figure 1.3. Alteration of form by changing contour lines. (a) Square contour lines of pyramid altered to concentric circular contour lines. (b) Horizontal planes of circular contours stacked in layer cake–like manner. (c) Isometric of resultant conical form.

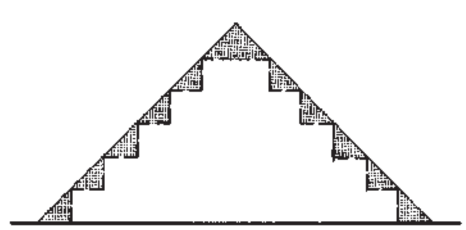


Figure 1.4. Surface smoothing between adjacent contour lines.

The step-like form that results from stacking the successive planes is indicated by the dashed line, and the smoothing effect that results from assuming a gradual transition is indicated by the shaded triangles. It is this smoothing effect that gives the cone and pyramid their true form. Again, stadium seating provides a good example of the step-like character created by adjacent contours where a smooth transition has not been taken into consideration.

These examples are oversimplified in their approach, since they deal with basic geometric forms and straightforward alterations. However, the landscape consists of numerous geometric shapes occurring in complex combinations. The ability to dissect landforms into their various component shapes and to understand the relationship of the shapes to each other will make the task of analyzing, interpreting, and visualizing the landscape easier. The difference in elevation between adjacent contour lines as illustrated by the steps in Figure 1.4 is defined as the *contour interval.* In order to interpret a topographic map properly, scale, direction of slope, and contour interval must be known. The most common intervals in U.S. Customary units are 1, 2, 5, 10, and multiples of 10 ft. In metric units, common intervals are 0.20, 0.50, and 1.00 meters. Selection of a contour interval is based on the roughness of the terrain and the purpose for which the topographic plan is to be used. It is obvious that as the map scale decreases (for example, changing from 1 in. = 20 ft to 1 in. = 100 ft or 1:250 to 1:1,000 for the same area) or the contour interval increases, the amount of detail, and, therefore, the degree of accuracy, decreases (Figure 1.5).

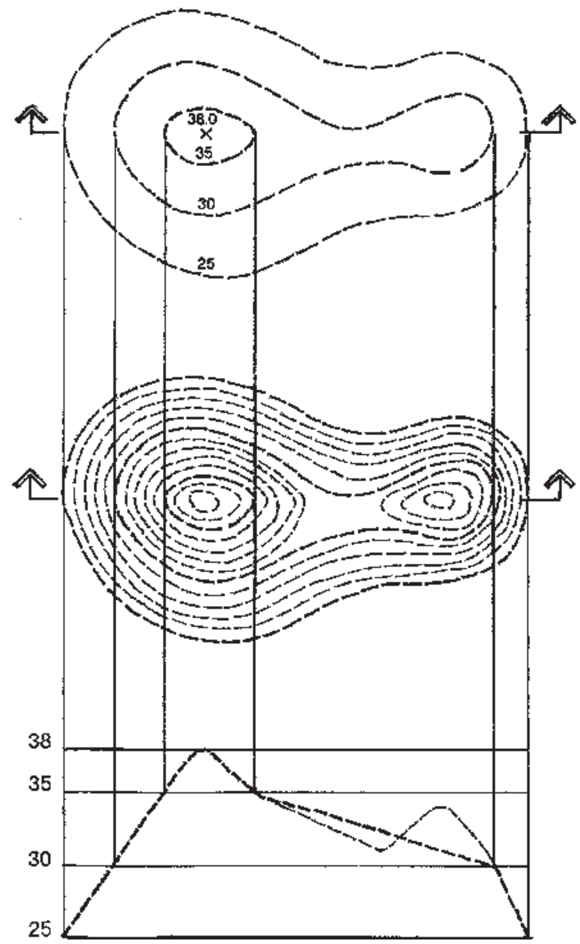


Figure 1.5. Contour interval and accuracy of form.

CONSTRUCTING A SECTION

Analyzing topography and landform can be accomplished by constructing a section. A *section* is a drawing made on a plane, which vertically cuts through the earth, an object like a building, or both. The ground line delineates the interface between earth and space and illustrates the relief of the topography. To draw a section, follow the procedure outlined in Figure 1.6.

In Figure 1.6, the highest elevation of the landform occurs between the 13 ft and the 14 ft elevations. Therefore, a peak, or high point, must occur between the two intersections along the 13 ft elevation line. A similar condition, and how it may be misinterpreted due to degree of accuracy, is illustrated in Figure 1.5.

CONTOUR SIGNATURES AND LANDFORM

It becomes apparent in analyzing landform that certain geomorphic features are described by

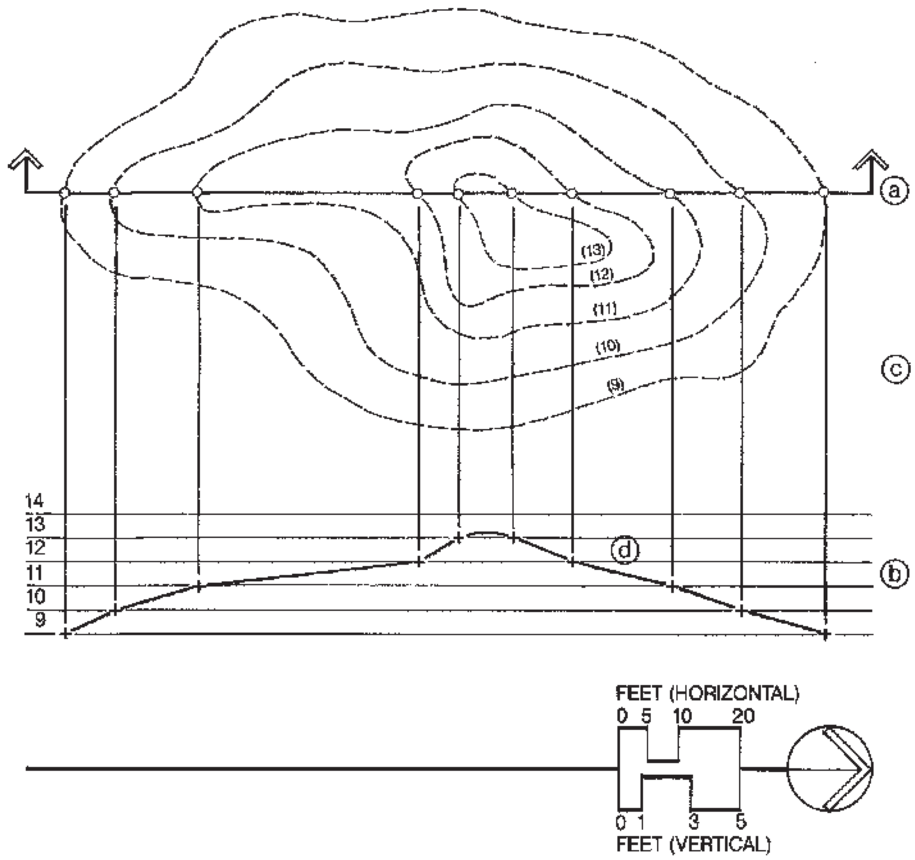


Figure 1.6. Drawing a section. (a) Indicate cutting plane. (b) Draw parallel lines according to contour interval and proposed vertical scale. (c) Project perpendicular lines from the intersection of the contour line with the cutting plane to the corresponding parallel line. (d) Connect the points to complete the section and delineate the ground line.

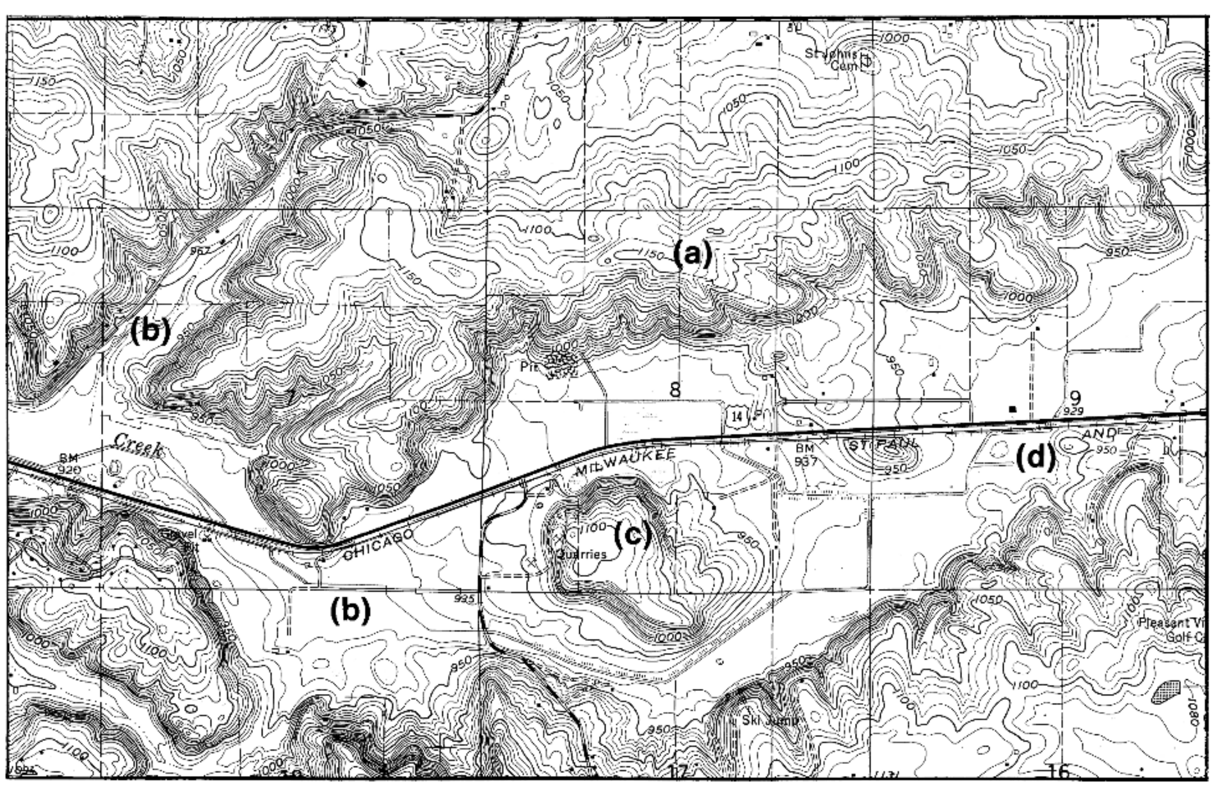


Figure 1.7. Contour signatures. (a) Ridge. (b) Valley. (c) Summit. (d) Depression.

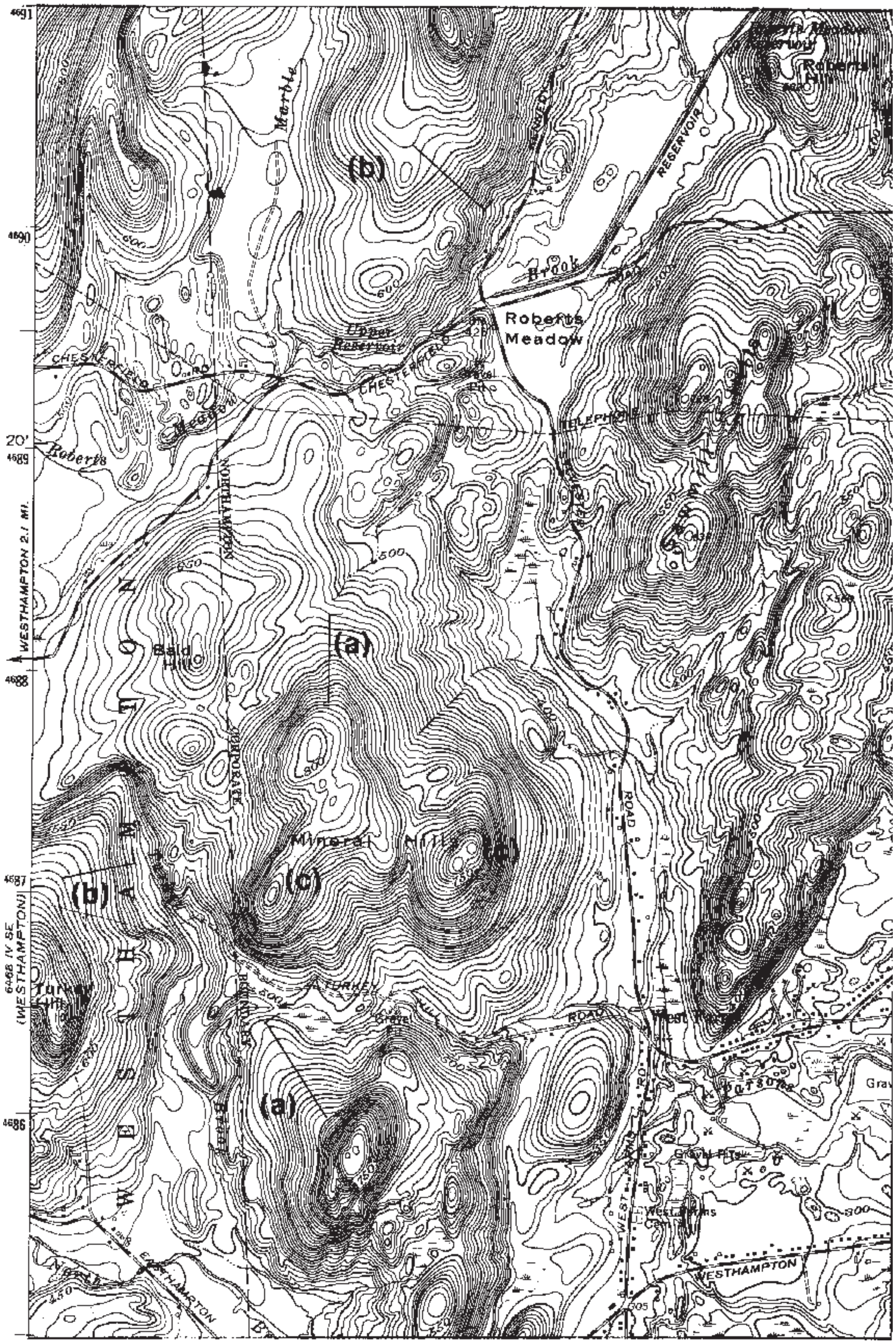


Figure 1.8. Contour signatures. (a) Concave slope. (b) Convex slope. (c) Summit.

distinct contour configurations. These configurations may be referred to as *contour signatures*. Typical contour signatures are identified on the contour maps (portions of United States Geological Survey quadrangles) in Figures 1.7 and 1.8.

Ridge and Valley

A *ridge* is simply a raised elongated landform. At the narrow end of the form, the contours point in the downhill direction. Typically, the contours along the sides of the ridge will be relatively parallel and there will be a high point or several high points along the ridge.

A *valley* is an elongated depression that forms the space between two ridges. Essentially valleys and ridges are interconnected, since the ridge side slopes create the valley walls. A valley is represented by contours that point uphill.

The contour pattern is similar for both the ridge and valley; therefore, it is important to note the direction of slope. In each case, the contours reverse direction to create a U or V shape. The V shape is more likely to be associated with a valley, since the point at which the contour changes direction is the low point. Water collects along the intersection of the sloping sides and flows downhill, forming a natural drainage channel at the bottom.

Summit and Depression

A *summit* is a landform, such as a knoll, hill, or mountain, that contains the highest point relative to the surrounding terrain. The contours form concentric, closed figures with the *highest* contour at the center. Since the land slopes away in all directions, summits tend to drain well.

A *depression* is a landform that contains the lowest point relative to the surrounding terrain. Again, the contours form concentric, closed figures, but now the *lowest* contour is at the center. To avoid confusion between summits and depressions, it is important to know the direction of elevation change. Graphically, the lowest contour is often distinguished by the use of hachures. Since depressions collect water, they typically form lakes, ponds, and wetlands.

Concave and Convex Slopes

A distinctive characteristic of *concave* slopes is that the contour lines are spaced at *increasing* distances in the downhill direction. This means that the slope is steeper at the higher elevations and becomes progressively flatter at the lower elevations.

A *convex* slope is the reverse of a concave slope. In other words, the contour lines are spaced at *decreasing* distances in the downhill direction. The slope is flatter at the higher elevations and becomes progressively steeper at the lower elevations.

Uniform Slope

Along a uniform slope, contour lines are spaced at *equal* distances. Thus, the change in elevation occurs at a constant rate. Uniform slopes are more typical in constructed rather than natural environments.

CHARACTERISTICS OF CONTOUR LINES

The following points summarize the essential characteristics associated with contour lines. Since many of the concepts and principles discussed in subsequent chapters relate to these characteristics, a thorough understanding must be achieved before proceeding.

1. By definition, all points on the same contour line are at the same elevation.
2. Every contour line is a continuous line, which forms a closed figure, either within or beyond the limits of the map or drawing (Figure 1.9).
3. Two or more contour lines are required to indicate three-dimensional form and direction of slope (Figure 1.10).

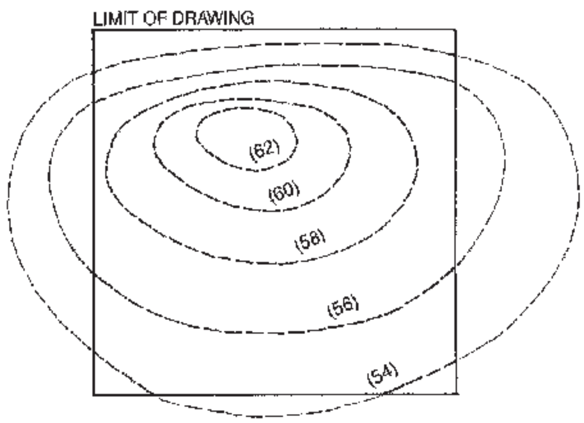


Figure 1.9. Closed contours. Contours are continuous lines creating closed figures. However, closure may not always occur within the limits of a drawing or map.

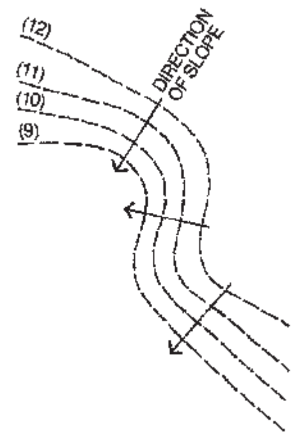


Figure 1.10. Direction of slope. The steepest slope is perpendicular to the contour lines. Consequently, surface water flows perpendicular to contour lines.

4. The steepest slope is perpendicular to the contour lines. This is a result of having the greatest vertical change in the shortest horizontal distance.
5. Consistent with the preceding point, water flows perpendicular to contour lines.
6. For the same scale and contour interval, the steepness of slope increases as the map distance between contour lines decreases.
7. Equally spaced contour lines indicate a constant, or uniform, slope.
8. Contour lines never cross except where there is an overhanging cliff, natural bridge, or other similar phenomenon.
9. In the natural landscape, contour lines never divide or split. However, this is not necessarily true at the interface between the natural and built landscape, as illustrated in Figure 1.11.

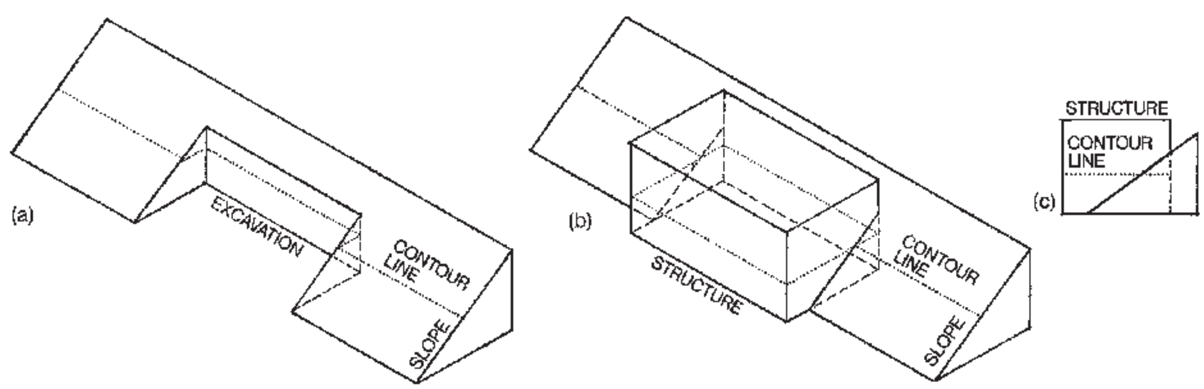


Figure 1.11. Technically, contour lines never divide or split where they are used to represent the surface of the earth. However, at structures, contour lines may also be drawn across the face of the constructed object, thus providing a split appearance. (a) The contour line follows along the face of an excavation made in a slope. (b) The contour line follows along the face of the excavation as well as along the face of the structure placed in the excavated area. (c) End section illustrating the relationship between the slope and the structure.

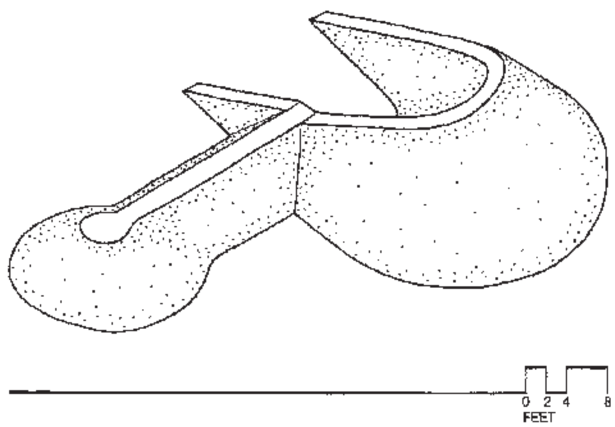


Figure 1.12. Axonometric of landform for Exercise 1.1a.

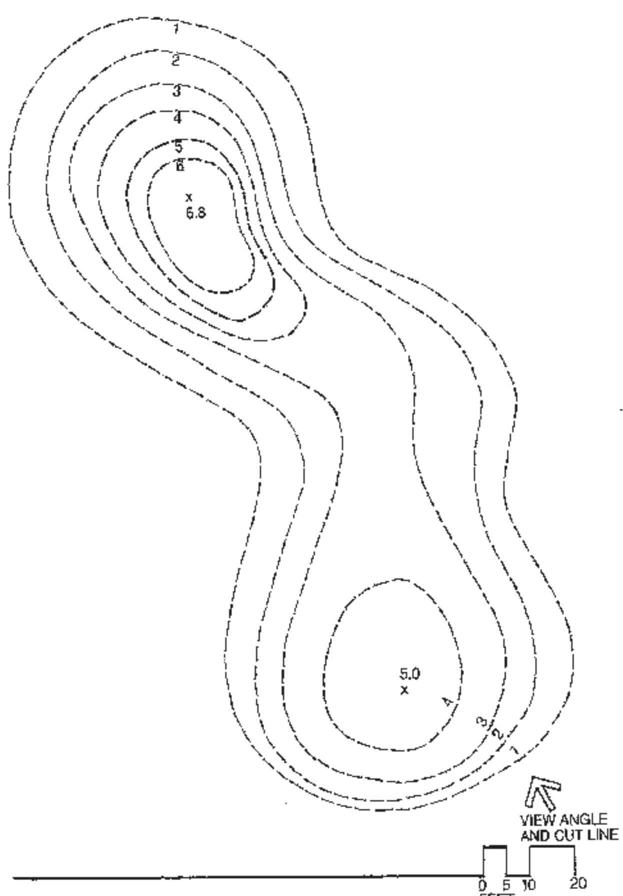


Figure 1.13. Contour plan for Exercise 1.1b.

EXERCISES

1.1. The intent of this two-part problem is to develop your ability to visualize landform from contours. (a) Draw a contour plan of the landform in Figure 1.12. Use a minimum of eight contour lines to depict the form. (b) Draw an oblique aerial perspective of the landform represented by the contour plan shown in Figure 1.13.

1.2. Exercise 1.1 required the visualization of landforms and contour lines using two-dimensional graphics. An easier but more time-consuming method for interpreting contours is through the use of three-dimensional models. Construct two models: the first of the contour plan in Exercise 1.1b and the second of the more architectural landform illustrated in Figure 1.14. Once constructed, these models may be used to analyze various contour line relationships, such as relative steepness, concave and convex slopes, etc.

1.3. The first two exercises address the issue of understanding the three-dimensional forms created by contour lines using graphic and

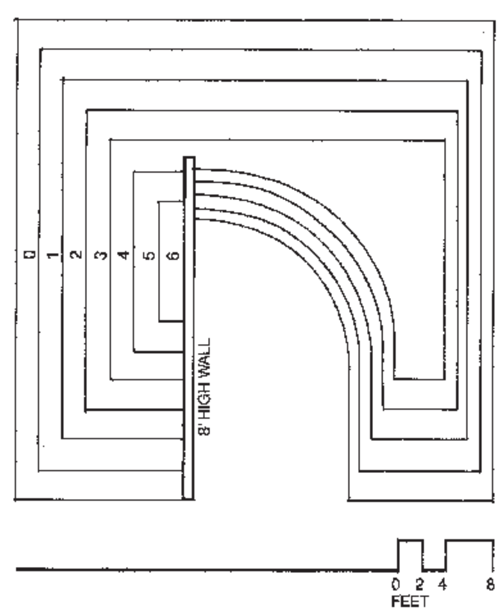


Figure 1.14. Contour plan for Exercise 1.2.

model techniques. However, these methods are still somewhat abstract, since they are not related directly to the landscape. There are two techniques that may be used to place contour lines and form in a realistic context: (a) by “drawing” contour lines with lime directly on the ground, etching lines in snow (if the weather is appropriate), or by using string or surveyor’s flagging, and (b) drawing contour lines on a map from an on-site visual analysis. Select a small area with a variety of topographic conditions and attempt one or both of these techniques. As a clue to laying out contour lines there are numerous features in the landscape that can help determine relative differences in slope and elevation. These include stairs, brick courses on buildings, door heights, vegetation, people, etc. Keying on these features will make this task easier.

1.4. Construct a section of the landform in Exercise 1.1b along the cut line indicated. Use 1 in. = 10 ft for the horizontal scale and 1 in. = 5 ft for the vertical scale.