

## Activity 7: Topographic Maps II

### Maine Geological Survey



#### **Objectives:**

To have the students develop and be able to manipulate a grid coordinate system on their 7.5 minute series local topographic maps. To use the grid coordinate protractor (GCP) to plot azimuth values as a means of indicating direction on these maps; to be able to perform simple map traverses.

#### **Time:**

Grid mapping will take 30 minutes and the traverse will take 35 minutes to perform.

#### **Background:**

Once the domain solely of military analysts and professional cartographers, the ability to pinpoint an exact location on the earth's surface is now useful in a great many fields including mineral exploration, pollution analysis and control, development and zoning activities, construction, and communications.

While a number of grid coordinate systems exist, all of them use some type of projected lines off a globe representation of the earth. On the 7.5-minute maps, Universal Transverse Mercator (UTM) lines are used. UTM numbers are printed in the margins of the map with usually a larger central pair of numbers surrounded by 4 or 5 smaller ones, 0012000, for example. At this point a general discussion of longitude lines (which measure east-west position) and latitude lines (which measure north-south position)

may be useful. Many atlases and even road maps use a simplified version of this grid system. See the DeLorme Atlas City Maps for example.

The concept of azimuths or degree bearings may be familiar to students who have had geometry. Again a simple discussion of the compass points and the number of degrees in the circle is useful (See Figure 1).

Students with experience in scouting and similar organizations may have considerable expertise in this type of activity and should be encouraged to help their peers.

### **Materials:**

Students, ideally, should each have their own map for this activity. You may wish to have all students purchase their own maps if you are going to do an entire unit or section on mapping. Each student will also need a meter stick.

### **Procedure:**

**PROTRACTOR:** Using the sample enclosed, duplicate one copy per student onto clear plastic (Figure 2).

**GRIDDING MAP:** (Some of the newer quadrangles already have the grid lines on them.) To grid the map, lay the map on a flat surface and, using the meter stick, draw a thin but distinct line between corresponding UTM numbers on opposite sides (or ends) of the map. Repeat this process until the entire map is covered by a grid of parallel lines. The two larger print digits in each UTM number will be the base number for each line drawn on the map. For example, the bottom most UTM number in the Turner Center Quadrangle is 4901000 in its entirety (See Figure 3). This line will be the 01 line for this map. Notice that the UTM numbers are written just below or just to the end of faint blue lines that extend into the margins of the map. The lines will always be there on the margins even if the numbers are not. When the map has been completely ruled off, neatly label all the horizontal lines up the middle of the map and label all of the vertical lines across the middle of the map. See sample of Rome provisional quadrangle map in front binder pocket.

The coordinates for any point on the map can now be expressed as an 8 digit number such as 09360215. The general expression in reference to reading these coordinates is RIGHT-UP. The first four numbers (read left to right) will locate the east-west position on a horizontal grid line. The last four numbers (read bottom to top) locate the north - south position. The intersection of these lines marks the exact location of your point - which can be any geographic or man-made feature. In each eight digit number the first and third pairs of numbers come off the map, while the second and fourth pairs are obtained by using the coordinate protractor. The protractor is placed with the zero degree mark at the top so the square lines up with the bottom and right hand side of one of the grid squares. The second pair of digits comes off the bottom scale (RIGHT) and the fourth pair of digits comes off the side scale (UP) (See discussion on student sheet). Thus the coordinates for the highest point on Mosher Hill (see attached map portion) are 32543582. It should be noted when reading the bottom scale that the numbers decrease from left to right. Thus the following point:

3 ↓ 1 1 1 1 2 would be read as 29

A map traverse consists of the following steps. Locate a point, using the GCP to define its coordinates. Determine a direction to follow, which is called an azimuth, in degrees. Follow this azimuth a specified distance using the map scale and arriving at a new point. Use the GCP to identify the coordinates of the new point. As students gain expertise, the traverses can become more complex employing multiple steps, back azimuths (180 degrees from the given direction), and triangulation. A very challenging exercise is to let the students make up each-others test traverse.

### **Follow-Up:**

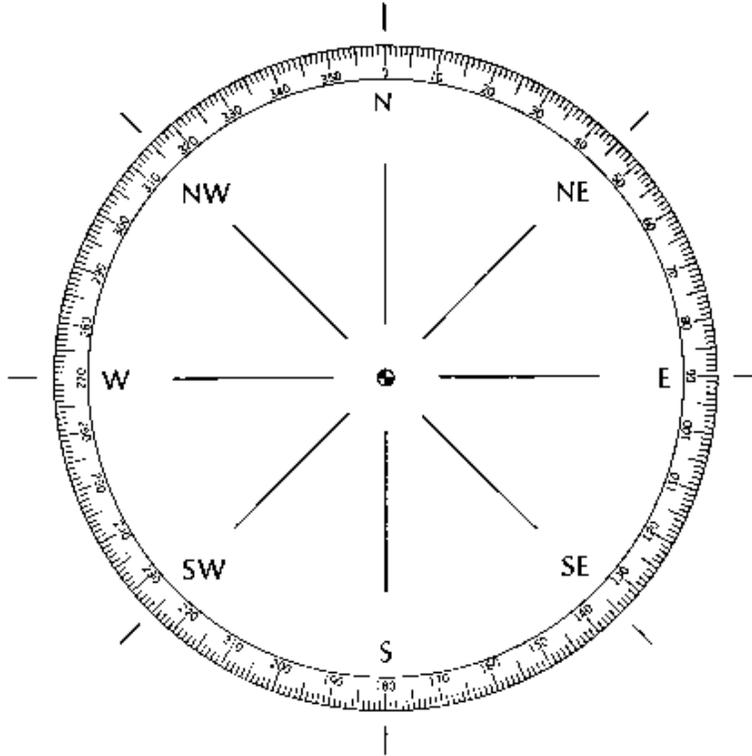
Invite a professional cartographer or draftsman to explain to the group how he/she locates objects. Take the group to see a computer assisted mapping facility.

Add adjacent quadrangles to your already gridded one extend the grid lines and add those that are missing. Now plot traverses over much larger distances. Students will have to be very careful in determining their azimuths to maintain accuracy.

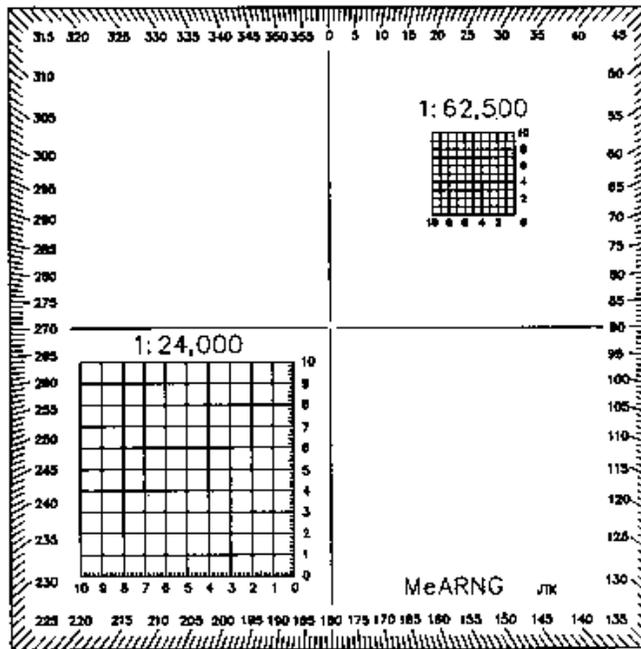
If the terrain is appropriate locally, have students convert map azimuths to magnetic (compass) azimuths and do some actual land traverses using the map. See U.S. Army Field Manual 21-26 for a discussion of the necessary techniques.

**References:**

Activity developed by Duane Leavitt with materials and concepts modified from U.S. Army Field Manual FM 21-26, Map Reading (Department of the Army, 1969).



**Figure 1.** Comparison of selected compass points with corresponding degree values.



**Figure 2.** Grid coordinate protractor (GCP). (Provided by Major Logan, US Army National Guard, Camp Keyes, Augusta, Maine)

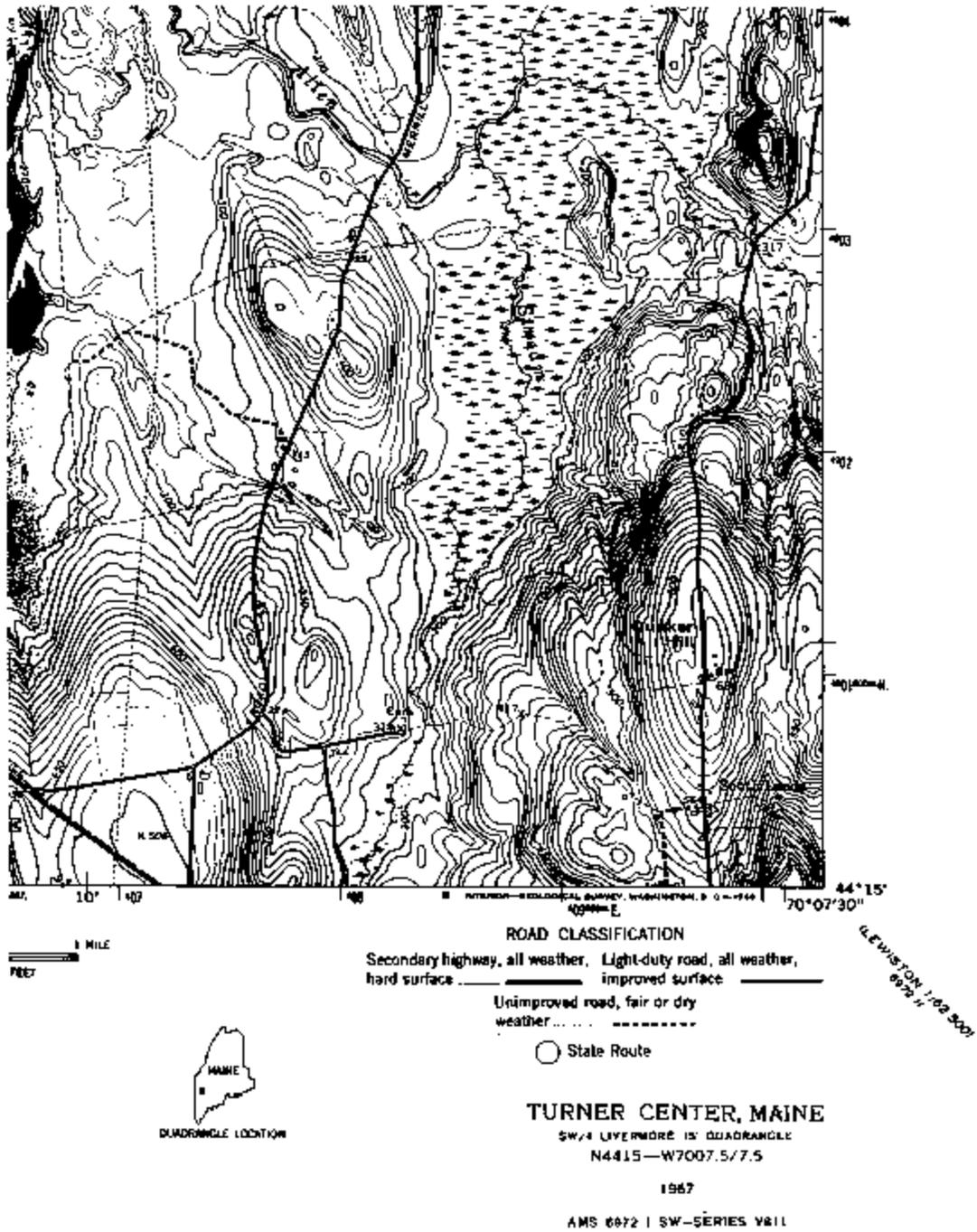


Figure 3. Turner Center quadrangle.

Name \_\_\_\_\_



## **Activity 7: Topographic Maps II**

### **Maine Geological Survey**

#### **Student Sheet**

#### **Purpose:**

In this activity you will learn how to read and plot map coordinates, read and plot azimuths, and you will use both these skills to learn how to plot and follow a map traverse.

#### **Materials:**

A Grid Coordinate Protractor (GCP), 7.5-minute series topographic map, meter sticks, pens, pencils, and notebooks.

#### **Part I:**

Lay your map on a flat surface and locate the Universal Transverse Mercator (UTM) projection lines and numbers; these are located in the margins on all four sides of the map. The UTM numbers will have the following form although the actual numbers will vary from quadrangle to quadrangle. Here is a typical UTM number and mark: 4902000 m N.

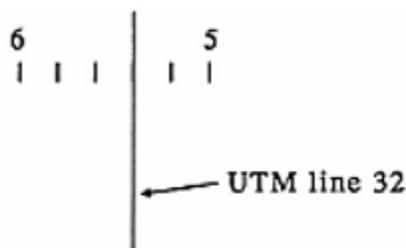
Notice that a UTM number on one side of the map will ALWAYS have either a corresponding mark or mark and number on the opposite side of the map. Once you have located all the UTM numbers, connect corresponding numbers by drawing a straight line in pencil on the map. Continue this process until all UTM numbers of the same value have been connected. When you are done you will have a graph or grid

drawn on your map; each square in the grid will measure exactly  $13/8$  by  $13/8$  inches. All your vertical lines should be roughly parallel to the sides of the map; all horizontal lines should be roughly parallel to the top and bottom of the map. Have your instructor check your map. Change any lines that your teacher indicates. Label the lines on your map as indicated by your instructor; all lines should be labeled with a two digit number such as 58 or 03. (See Sample Map 1).

## Part II:

You now have the tools, a gridded map and a GCP, to locate any point on the map to within 100 square feet. Look at the location on Sample Map 1 marked with a big arrow, the highest point on Mosher Hill. Notice that the hilltop lies between the 32 and 33 vertical lines and between the 35 and 36 horizontal lines. Orient the GCP so that the numbers around the outside edge read clockwise. Place the protractor so that the two coordinate scale zeros are at the lower left corner of the grid square bounded by the above lines. Keeping the scale on the lower horizontal grid line, slide the GCP to the right until the point for which coordinates are desired (the top of Mosher Hill) touches the edge of the scale. Coordinates are read where the starting grid line crosses the bottom scale and the point touches the side scale. Notice that the UTM line marked 32 crosses the bottom scale of the GCP at the second black mark beyond the 5.

Location of UTM line with reference to bottom GCP scale:



Each division is equal to two units; there are no decimal points. You now have the first four digits in an 8 digit grid coordinate number. These numbers are 3254 and give the east-west position of the hilltop on the map; these numbers are read from left to the right.

Now look at the side or vertical scale of the GCP; notice that the "x" which represents the hilltop is near the top of the scale at the 82 position. Using the same process as

above, the last four numbers are 3582. These give the vertical position of the feature and are read bottom to top or up. The full location of the top of Mosher Hill is, therefore, 32543582. Remember that the first four numbers are read RIGHT and the last four numbers are read UP. Also notice that the first and third pairs of numbers, 32 and 35, come from the lines drawn on the map and the second and fourth pairs of numbers, 54 and 82, come from the GCP.

Now use YOUR local quadrangle map and GCP to find the coordinates of the following.

1. Highest point \_\_\_\_\_
2. Location of your school \_\_\_\_\_
3. Lowest point \_\_\_\_\_
4. Approximate center of largest body of water \_\_\_\_\_
5. Largest swamp \_\_\_\_\_
6. Church/hilltop closest to school \_\_\_\_\_
7. Other (as directed by instructor) \_\_\_\_\_

Check these coordinates against the values your instructor has and resolve any differences.

### **Part III:**

Now that you can locate points on the map, you are ready to travel between them. Place the large cross in the center of your GCP over the center of the highest point. The 0 degree reading should be at the top of the GCP and the numbers, 0 to 359, should read clockwise around the edge. Make sure the edges of the GCP are lined up parallel with the grid lines. Place a ruler or meter stick so that it connects the center cross of the GCP and your school. The number that the ruler passes through on the edge of the GCP is the direction or azimuth to your school. It is measured in degrees.

Record this azimuth here: \_\_\_\_\_.

Now place the GCP on your school and, as in the above procedure, find the azimuth to the highest point on the map; record it here: \_\_\_\_\_.

Are these two values the same? If not explain why:

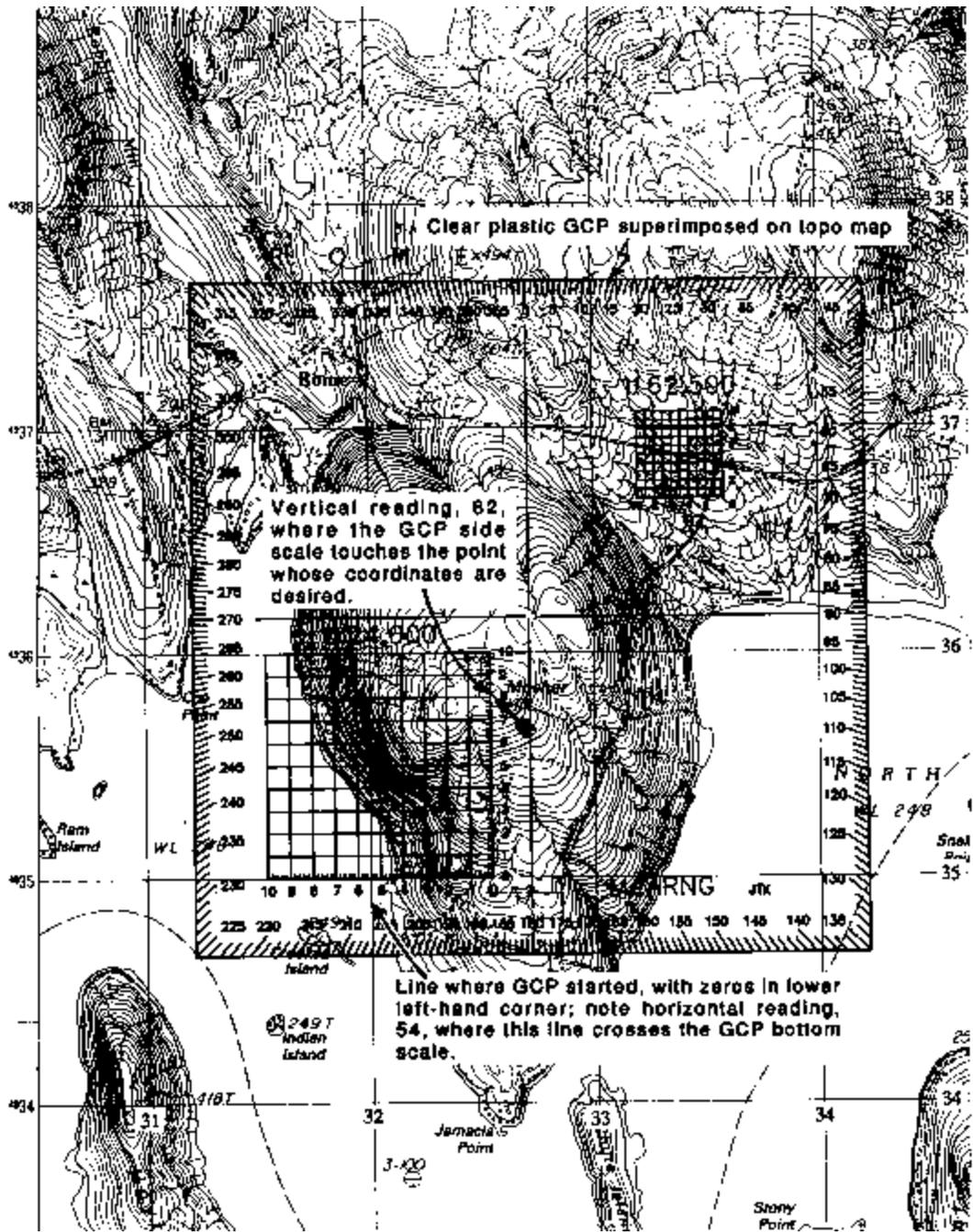
What is the relationship between these two azimuths?

Now use the GCP and a ruler to find the azimuth and distance between your school and the following locations in the table.

	<b>Location</b>	<b>Azimuth</b>	<b>Distance</b>
1	Lowest Point		
2	Largest body of water		
3	Nearest swamp		
4	Nearest church/hilltop		
5	Nearest tarred road		
6	Nearest woodland		

### **Questions and Discussion:**

1. What would be the actual difference in distance between coordinates of 06290494 and 06300495?
2. Could one use a GCP and 7.5-minute series map and still allow for minor errors or differences? Explain.
3. Construct a traverse consisting of grid coordinate values, azimuths and distances; have another team of students follow this traverse and see if they come out at your predetermined point.



**Sample Map 1** Shows clear plastic GCP superimposed on topographic map and gives example of a vertical reading of 62 and a horizontal reading of 54.