Structured Experience 4.1
Precipitation

Goals

1. To have students begin learning how to delineate a watershed.
2. To learn how to calculate average precipitation by various methods, especially polygons.
3. To become familiar with precipitation frequency analysis.

Group Size

Groups of six each.

Time Required

About three hours.

Materials

(a) Watershed Mapping

1. One copy of a topographic map for each participant (page 7) plus one extra copy for each group.
2. One copy of the Watershed Delineation Rules (page 3) for each participant.

(b) Average Precipitation

3. One copy of a dot grid for each member of a group (page 8).
4. One overhead pen for each member of a group.
5. One set of dividers for each member of a group.
6. One small ruler for each member of a group.
7. One copy of the Watershed Area and Average Precipitation Worksheet (page 4) for each member of a group.

(c) Frequency Analysis

8. One copy of Precipitation Frequency Analysis (pages 5–6) for each participant.

Physical Setting

A large room with tables or desk chairs where groups can work together.

Process

Watershed Mapping

1. The facilitator gives a lecturette on watershed mapping, emphasizing the basic rules, and hands out the Watershed Delineation Rules. (15 min)
2. The facilitator passes out the topographic maps and instructs the participants to delineate the watershed at the confluence of Hunter Creek and Midway Creek above the triangle. Participants are encouraged to work independently. (20 min)

3. The facilitator arranges the participants into groups and the participants are asked to develop a new line for the watershed boundary based on group consensus. Participants are asked to indicate the two lines on the map. The maps will be handed in at a later time. (10 min)

Average Precipitation

4. The facilitator hands out the Watershed Area and Average Precipitation Worksheet, dot grids, and overhead pens to each group and asks the participants to determine the area of their watersheds in hectares. (15 min) The facilitator may ask for values at this point.
5. The facilitator hands out rulers and dividers and asks the participants to develop Thiessen polygons for the rain gages in the watershed. The facilitator demonstrates how this is done on a document camera. (20 min)
6. The facilitator asks the participants to determine the relative area of each polygon and calculate the average precipitation. (20 min)
7. The facilitator leads a discussion on the merits of different methods of determining average precipitation. Also, the facilitator asks about the value of groups for this exercise. The facilitator collects the maps and worksheets. (10 min)

Frequency Analysis

8. The facilitator gives a lecturette on rainfall probability and precipitation frequency analysis. (20–30 min)
9. The facilitator passes out one copy of Precipitation Frequency Analysis to each participant.

Watershed Delineation Rules

Characteristics of contour lines:

- contour lines do not cross;
- closely spaced contour lines represent steep slopes;
- contour lines that form a V, point upstream.

Rules

1. Start at the bottom of the watershed, for example on a stream.
2. The watershed boundary must cross contour lines perpendicularly.
3. Do not draw the boundary parallel to any contour lines except on saddles.
4. Join hills surrounding the stream as points on the watershed boundary.
5. Follow points of land.
6. Concave contour lines are hills; convex contour lines are valleys.
7. At the top of the watershed, place the line equally between adjacent contour lines.

Final Test: Pretend to place a raindrop within the watershed on the map and determine its path flowing downhill. If it crosses the watershed boundary, the boundary is incorrect.

Watershed Area and Average Precipitation Worksheet

1. At the confluence of Hunter Creek and Midway Creek, determine the watershed area (ha) (shown by a triangle on the topographic map on page 7).
   Area = _____ ha
2. Draw the Thiessen polygons for the rain gages inside and outside the watershed. Use a pair of dividers to construct the perpendicular bisectors between adjacent stations.
3. Determine the relative or absolute area enclosed in each Thiessen polygon. Use the dot grid to determine the areas.
4. Compute the average precipitation over the watershed using the polygon method and using the information for a 24-hour storm provided in the following table.

Station	24-Hour Rainfall (cm)	Dot Count	Relative Area	Weighted Precipitation (cm)
A	3.1			
B	3.9			
C	4.5			
D	6.7			
E	6.0			
F	5.2			
			TOTAL = _____	

5. Compute the average precipitation using the arithmetic method.
   Average precipitation = _____

Give two reasons why the two averages are not the same.

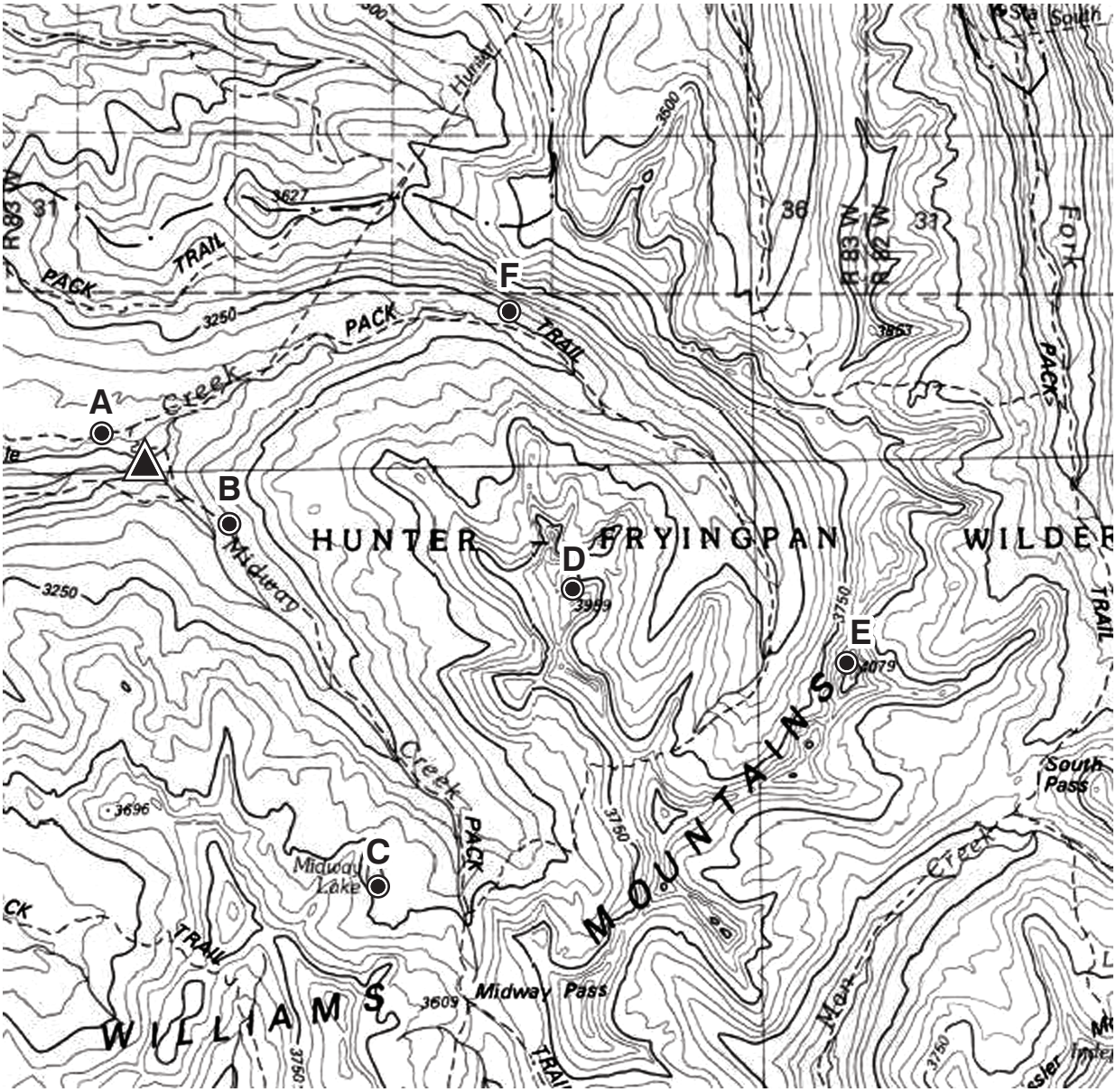
Precipitation Frequency Analysis

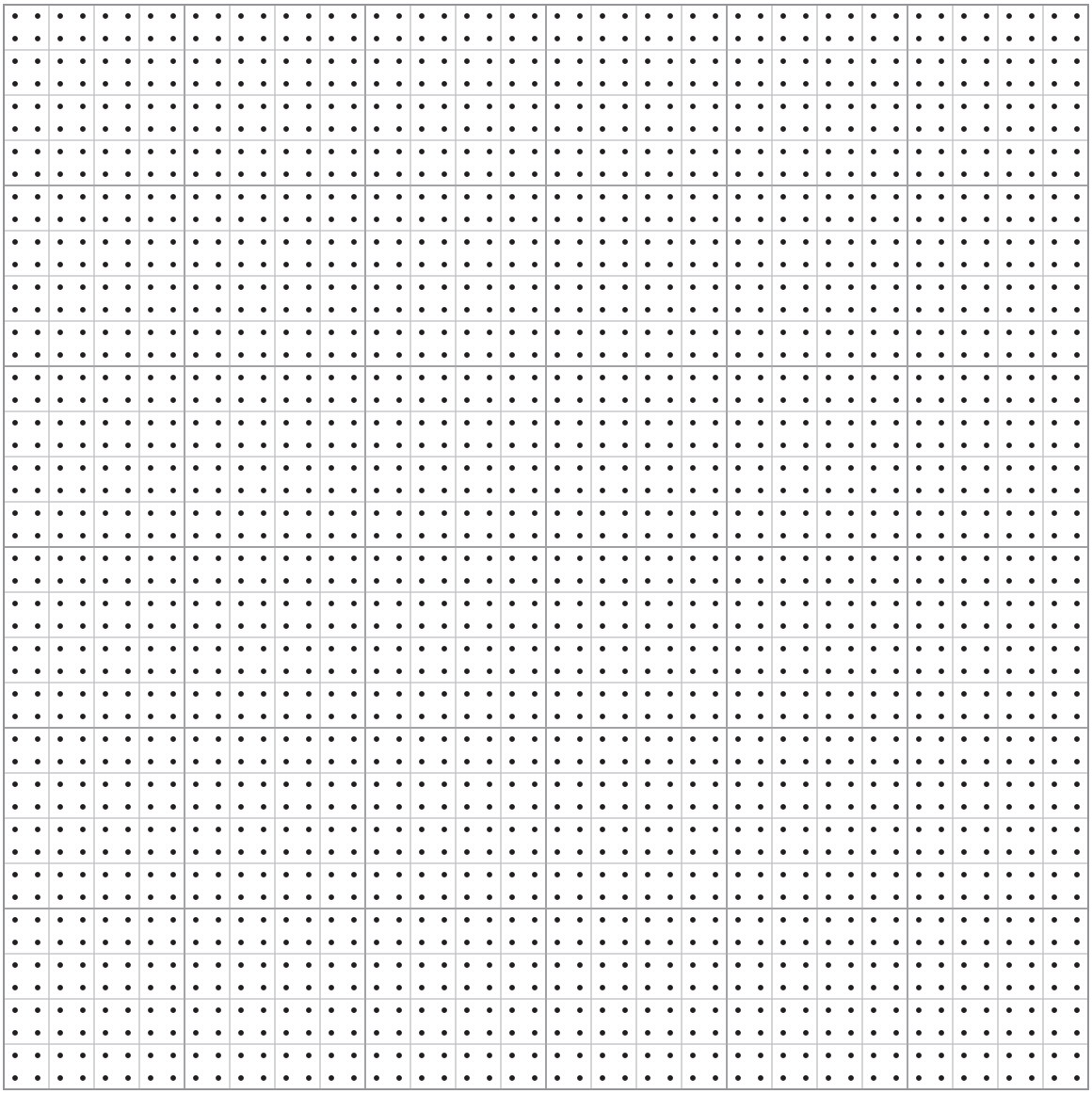
1. The following table gives annual precipitation for a 30-year (i.e., normal) period.
   (a) Calculate in Table 1 (page 6) and plot on probability paper the cumulative frequency distribution for these data. Fit a line through the data by eye.
   (b) Determine, using the figure derived in (a) above, the mean annual precipitation and the standard deviation. The standard deviation (s) is 34% above and below the mean.
   P = _____ s = _____
   (c) Determine the probability of obtaining a rainfall of greater than 700 mm in any one year.
   p = _____
   (d) What is the precipitation for the 50-year recurrence interval?
   P = _____
   (e) What is the probability that the 50-year precipitation will occur in the next five years?
   p = _____
2. Include the graph and table when you hand in your results. Be sure that the axes are clearly labeled and that the figure and table are titled, such as in your textbook. The figure should also be neat. Points will be taken off for incomplete figures. Don't forget units on this sheet and on the figure!

Rainfall		Rainfall		Rainfall	
Year	(mm)	Year	(mm)	Year	(mm)
1961	1206	1971	1185	1981	1429
1962	1245	1972	987	1982	610
1963	932	1973	839	1983	1452
1964	1480	1974	1196	1984	741
1965	1193	1975	1133	1985	746
1966	1397	1976	1163	1986	982
1967	1369	1977	1781	1987	1115
1968	1292	1978	1121	1988	917
1969	937	1979	624	1989	1219
1970	1533	1980	815	1990	977

Table 1 _____

Rank	Rainfall (mm)	Probability (%)	Recurrence Interval (yrs)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
26			
28			
29			
30			



1000 0 5000 10,000 15,000 20,000 METERS

5000 0 10 000 20,000 30,000 40,000 50,000 60,000 70,000 FEET