

Lesson A2–3

Applying Profile Leveling Techniques

Unit A. Mechanical Systems and Technology

Problem Area 2. Soil and Environmental Technology Systems

Lesson 3. Applying Profile Leveling Techniques

New Mexico Content Standard:

Pathway Strand: Natural Resources and Environmental Systems

Standard: I: Recognize importance of resource and human interrelations to conduct management activities in natural habitats.

Benchmark: I-B: Apply cartographic skills to natural resources.

Performance Standard: 5. Use land survey and coordinate system.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain the important aspects of keeping survey notes for a profile survey.
2. Explain the steps involved in completing a profile survey exercise.
3. Explain how to calculate allowable error in a survey exercise.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

U3010b. *Surveying in Agriculture*. Urbana, Illinois: Vocational Agriculture Service, University of Illinois at Urbana-Champaign.

Other Resources. The following resources will be useful to students and teachers:

Benton, Arthur R., Jr., and Philip J. Taetz. *Elements of Plane Surveying*. New York, New York: McGraw-Hill, Inc., 1991. (Chapter 3)

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters

Terms. The following terms are presented in this lesson (shown in bold italics):

Backsight
Benchmark
Elevation
Foresight
Height of instrument
Profile leveling
Station
Turning point

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Discuss with the students why producers sometimes put drainage ditches in their fields. They do this to drain away excess water. Talk with the students about the important characteristics of that drainage ditch. Is it important that the water flow a certain direction? What can a producer do to insure that the water flows in the direction wanted?

Summary of Content and Teaching Strategies

Objective I: Explain the important aspects of keeping survey notes for a profile survey.

Anticipated Problem: What are the important aspects of keeping survey notes for a profile survey?

- I. No aspect of surveying work is more important than keeping accurate records of field notes. Surveying notes must be recorded legibly and accurately in a field book as the work is done. Notes should not be recorded on scratch paper first and later transferred to a book. Doing this introduces an opportunity for error. The field notes reflect the quality of the work done. Professional looking notes indicate professional quality work in measurement and readings. Other surveyors completing later surveys often refer to survey notes. When making entries in the field book, a 3-H or 4-H pencil should be used. Pen or soft lead pencil marking may become smeared and unreadable over time. Avoid erasures of data since this also makes the validity of the data questionable. Make corrections by drawing a single thin line through the incorrect data and writing the correct entry above. Misspelled words, however, may be erased. There are several important sections included in a field notebook. Each part plays a specific role in the accurate completion of the leveling exercise. The different sections are:
 - A. Table of Contents—Leave a few pages blank at the beginning of the book for a table of contents. On this page, the recorder should make a brief description and a page reference for each activity completed. Include enough information so that someone examining the table of contents can identify the work done, the place, and the date it was completed.
 - B. Paging—A survey activity may require one or more sets of facing pages. Each set is considered one page when pages are numbered. Begin a new day's work on a new page.
 - C. Form of Entries—Printed entries are generally more legible than written entries. Field notes should be arranged according to the standard form that has been developed. This form outlines specific information, which should be found on each of the facing pages.
 1. Left-hand page—This page includes a legal description of the land and the type of survey at the top of the page. The recorder should place column headings between the first two horizontal lines at the top of the page. Readings should be recorded and tabulated in these columns as well. It is important to record figures with the decimal point and digits in line vertically. Show precision of readings by recording significant zeros. (i.e. 4.7 compared to 4.70) The column heading which should be found in the survey notes are:
 - a. **Station (Sta.)**—Location of the leveling rod when the reading is being taken.
 - b. **Backsight (BS)**—A level reading taken on a point of known or assumed elevation.
 - c. **Foresight (FS)**—A level reading taken on a point of unknown elevation.

- d. **Height of Instrument (HI)**—The elevation of the level line of sight with respect to the benchmark, as indicated by the cross hairs in the telescope. Height of instrument is calculated by adding the backsight to the elevation of the benchmark or turning point whichever is being used.
 - e. **Elevation (Elev.)**—The height of a point relative to the benchmark location of the survey. Elevation is calculated by subtracting the foresight from the height of instrument.
2. Right-hand page—The date, time of day, and weather conditions should be recorded on the top left of this page. The names and duties of the survey party should be recorded at the top right of the right-hand page. The type and number of the surveying instrument may also be recorded there. Also included on this page should be a sketch of the survey. Sketches should be to general proportions. Indicate north on all sketches using conventional signs and symbols. The recorder should sign the lower right corner of the right-hand page.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand the important aspects of keeping survey notes for a profile survey. Surveying in Agriculture is recommended. Use TM: A2–3A to provide an example of a field notebook’s table of contents.

Objective 2: Explain the steps involved in completing a profile survey exercise.

Anticipated Problem: What are the steps involved in completing a profile survey exercise?

- II. **Profile leveling** is the process of determining the elevations of a series of points at measured intervals along a line. A profile survey is extremely useful for locating drains, roads, dams, and other earth structures. The usual procedure is to determine the profile elevations, choose the grade elevations, and compute cuts or fills. Profile leveling is actually differential leveling with a number of intermediate foresights added between turning points. A **turning point** is a solid location, usually marked by a temporary stake, on which a foresight is taken, to which the instrument is moved, and from which a backsight is taken to determine a new height of instrument. Each foresight is subtracted from the first height of the instrument until the instrument is moved.
- A. The procedure for completing a profile survey is relatively simple. Take the first reading on a benchmark. A **benchmark** is a permanent point of known or assumed elevation from which leveling surveys are started. Then turn the instrument and take readings along the stations of the profile until it is necessary to establish a turning point. Move the instrument, compute a new height of instrument, and continue to take readings. After the foresights on stations along the profile have been taken, do not consider the survey finished until a differential leveling circuit is completed and a final reading is taken on the beginning benchmark.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand the steps involved in completing a profile survey exercise. Surveying in Agriculture is recommended. Use TM: A2–3B and TM: A2–3C to assist in the discussion on this topic.

Objective 3: Explain how to calculate allowable error in a survey exercise.

Anticipated Problem: How is allowable error calculated for a survey exercise?

- III. In leveling, errors can and will occur. These are most often done accidentally. The final error of closure in a leveling circuit is proportional to the square root of the number of rod readings. The formula assumes a distance of 100 feet for each rod reading. Therefore, we divide the total length of the traverse by 100, determine the square root of that dividend, and multiply by the factor of .014. For experienced surveyors, a less tolerant factor of .007 may be used. If the error of the survey is greater than the allowable amount calculated, the survey should be repeated.

A variety of techniques may be used to assist students in mastering this objective. Students should use text materials to understand how to calculate allowable error in a survey exercise. Surveying in Agriculture is recommended. Use TM: A2–3D to assist in the discussion on this topic.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application. Students should complete one or more profile leveling exercises in a familiar area.

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activity. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1 = h, 2 = c, 3 = g, 4 = e, 5 = b, 6 = f, 7 = a, 8 = d

Part Two: Completion

1. 3-H; 4-H
2. professional

Part Three: Short Answer

See Objective 1 in the lesson to score this item.

Test

Lesson A2–3: Applying Profile Leveling Techniques

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|--------------|-------------------------|---------------------|
| a. backsight | b. benchmark | c. elevation |
| d. foresight | e. height of instrument | f. profile leveling |
| g. station | h. turning point | |

- _____ 1. A solid location, usually marked by a temporary stake, on which a foresight is taken, to which the instrument is moved, and from which a backsight is taken to determine a new height of instrument.
- _____ 2. The height of a point relative to the benchmark location of the survey.
- _____ 3. Location of the leveling rod when the reading is being taken.
- _____ 4. The elevation of the level line of sight with respect to the benchmark, as indicated by the cross hairs in the telescope.
- _____ 5. A permanent point of known or assumed elevation from which leveling surveys are started.
- _____ 6. Process of determining the elevations of a series of points at measured intervals along a line.
- _____ 7. A level reading taken on a point of known or assumed elevation.
- _____ 8. A level reading taken on a point of unknown elevation.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

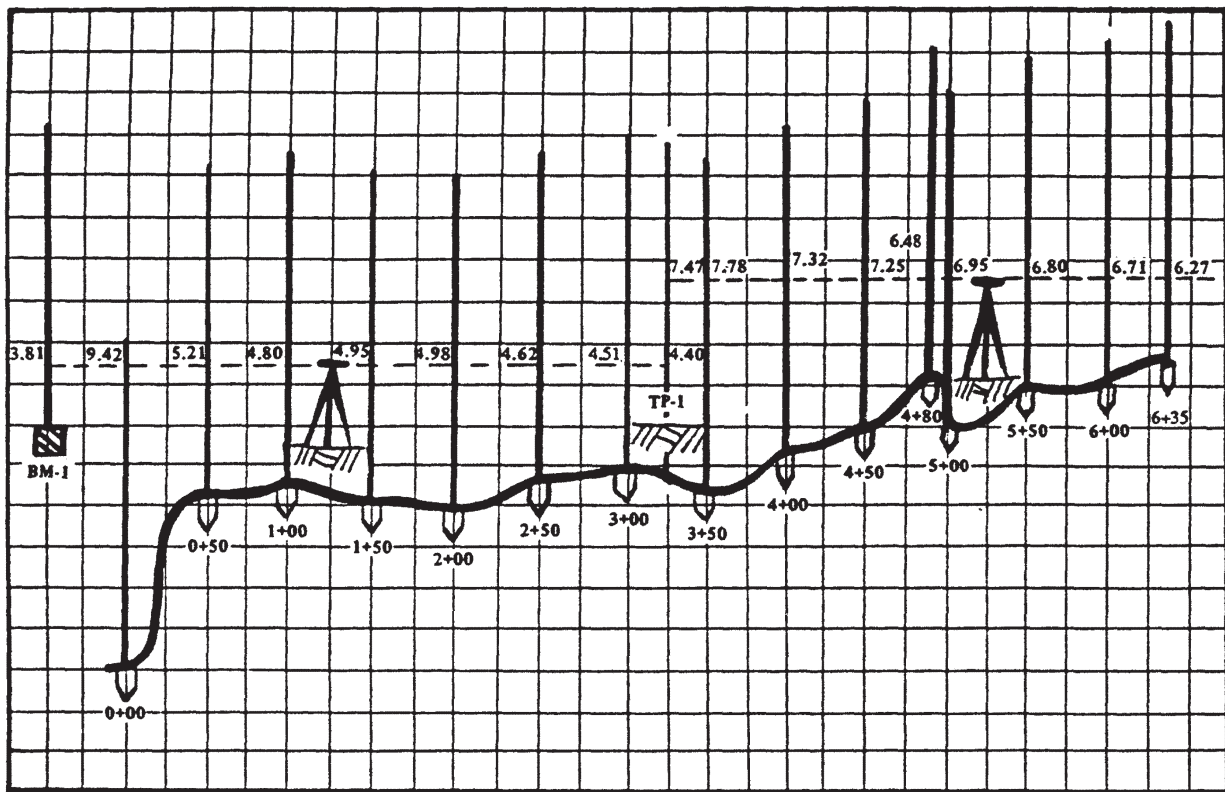
1. When making entries in the field book, a _____ or _____ pencil should be used.
2. Professional looking notes indicate _____ quality work in measurement and readings.

Part Three: Short Answer

Instructions. Provide information to answer the following question.

What items should be found on the left-hand page of field notes?

READINGS FROM A PROFILE LEVELING CIRCUIT



FIELD NOTEBOOK DATA ENTRIES

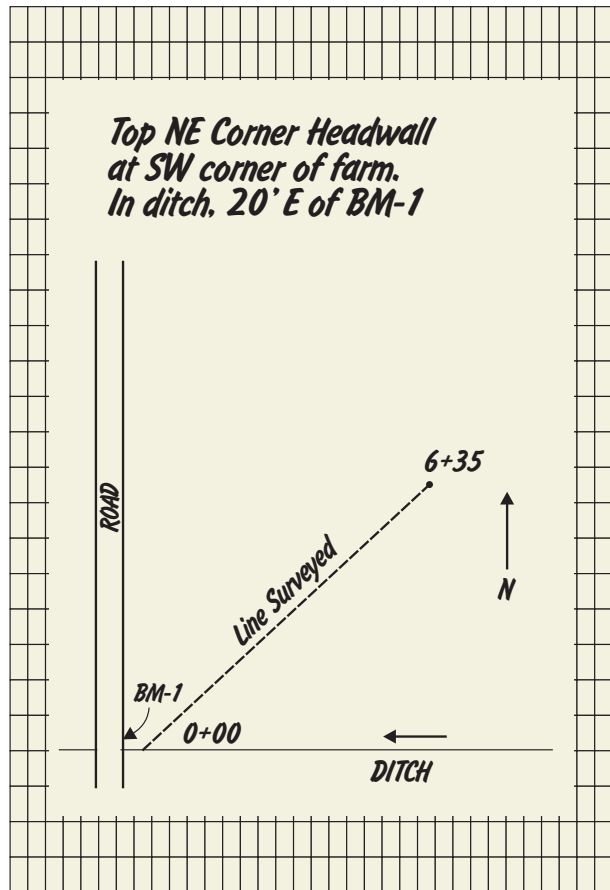
*Bob Hofmann Farm
NW 1/4 SW 1/4 Sect T3N R6W
Profile Leveling – Tile Drain*

*April 17, 20--
1-4 p.m.
Cold, Cloudy, Calm*

*Brian Myers
Kim Romine
Tom Jones
Level #372*



<i>Sta.</i>	<i>BS</i>	<i>HI</i>	<i>FS</i>	<i>Elev.</i>
<i>BM-1</i>	<i>3.81</i>			
		<i>103.81</i>		
<i>0+00</i>			<i>9.42</i>	<i>94.39</i>
<i>0+50</i>			<i>5.21</i>	<i>98.60</i>
<i>1+00</i>			<i>4.80</i>	<i>99.01</i>
<i>1+50</i>			<i>4.95</i>	<i>98.86</i>
<i>2+00</i>			<i>4.98</i>	<i>98.83</i>
<i>2+50</i>			<i>4.62</i>	<i>99.19</i>
<i>3+00</i>			<i>4.51</i>	<i>99.30</i>
<i>TP-1</i>	<i>7.47</i>		<i>4.40</i>	<i>99.41</i>
		<i>106.88</i>		
<i>3+50</i>			<i>7.78</i>	<i>99.10</i>
<i>4+00</i>			<i>7.32</i>	<i>99.56</i>
<i>4+50</i>			<i>7.15</i>	<i>99.63</i>
<i>4+80</i>			<i>6.48</i>	<i>100.40</i>
<i>5+00</i>			<i>6.95</i>	<i>99.93</i>
<i>5+50</i>			<i>6.80</i>	<i>100.08</i>
<i>6+00</i>			<i>6.71</i>	<i>100.17</i>
<i>6+35</i>			<i>6.27</i>	<i>100.61</i>
<i>TP-2</i>	<i>7.31</i>		<i>6.81</i>	<i>100.07</i>
		<i>107.38</i>		
<i>BM-1</i>			<i>7.39</i>	<i>99.99</i>
	<i>Error = 0.01'</i>			



Left- and Right-Hand Pages with Field Book Notes

CALCULATING FOR ALLOWABLE ERROR

Allowable error (E) = the square root of the dividend of the length of the traverse in feet divided by 100, times a factor of .014.

Example:

**In a survey that traverse was 3010 feet.
What is the allowable error? _____**

$$\begin{aligned} E &= \sqrt{3010/100} \times .014 \\ &= 5.486 \times .014 = 0.08 \text{ feet} \end{aligned}$$

Allowable error = 0.08 feet