

NSPS

**SURVEY TECHNICIAN CERTIFICATION
PROGRAM**

**LEVEL 3
SAMPLE EXAMINATION QUESTIONS**



NATIONAL SOCIETY OF PROFESSIONAL SURVEYORS

February 2024

This booklet has been prepared to provide an example of what an actual Certified Survey Technician (CST) Examination might be like. Using this as your only study guide is not recommended.

This examination is approximately 50% of an exam. The work element order is the same as in the full examination with approximately one half the number of questions (this will vary due to difference in the number of questions in some work element categories in the Boundary, Construction, Office specialties.)

These are not exactly questions from past exams, but do reflect the complexity and makeup of actual exam questions.

Additional information about the CST program and exam availability can be obtained at:

- www.cstnsps.com
- (240) 439-4615
- NSPS CST Program
21 Byte Court, Suite H
Frederick, MD 21702

A complete list of recommended books can be found on the CST website under the Applicants section. The recommended books mentioned are not particularly endorsed for any specific reason nor are they endorsed by the NSPS or other Survey related Association or Society. They represent a cross section of how, where, and what may be utilized as a resource to derive methods of study in preparation for the CST Exams.

At minimum an examinee should bring:

- 1). A Fundamental Surveying Text (with Unit Conversion Charts)
- 2). A First Aid & Safety Manual
- 3). A Surveying and Mapping Dictionary

LEVEL 3 QUALIFICATIONS

Field or Office Route:

3.5 years of progressive surveying experience or 65 transcribed semester hours, or quarterly equivalent, of which 18 semester hours are surveying/engineering related and 2.0 years of progressive surveying experience. Or any combination of education and work experience equivalent to related 3.5 years.

LEVEL 3

SURVEY TECHNICIAN CERTIFICATION

POSITION DESCRIPTION, WORK ELEMENTS AND NUMBER OF QUESTIONS

This is an open book exam.

POSITION DESCRIPTION

In addition to the Level I and II requirements, **Level III Technicians** are required to demonstrate a thorough knowledge of survey computations, types of surveys and field operations. The individual in this position is well versed with field note reduction and in-depth plan interpretation and preparation. The Level III technician possesses supervisory skills and a detailed working knowledge of standard field and office procedures. The technician had knowledge of the principles of the profession and various technical standards. Work Elements further describe the requirements related to this position.

Test problems will be taken from the following work elements: (# of questions from each Work Element)
(B = Boundary Exam) (C = Construction Exam) (O = Office Exam)

- 1) *Surveying Types and History* (B=5, C=5, O=5)
Knowledge of the different types of surveying and the basic differences between them.
Knowledge of the historical development of survey procedures and practices

- 2) *Field Equipment & Operations* (B=38, C=49, O=20)
Extensive knowledge of the principles and methods used in performing a variety of surveys such as: photo control surveys, state plane coordinate surveys, public land surveys, metes and bounds survey, GPS surveys, construction surveys, and as-built surveys
Extensive knowledge of proper field procedures, knowledge of the care, cleaning, and use of a variety of surveying tools and equipment, including data collectors and field radios. Know how to operate, check, and perform basic field adjustments on rods, compass, transits, levels, tribrachs, theodolites, total stations, robotic total stations, data collectors, tripods, and GPS equipment.
Knowledge on newer technologies such as Scanning/LIDAR, UAV, Mobile Mapping, GIS and BIM is expected. Some historical knowledge is also required.
Be able to coordinate field work for a variety of standard types of surveys. Know basic sources of measurement errors. Know principles of staking and stake markings. Know procedures for GPS surveys.

Know how to create, reduce, and check orderly field notes and data collector files for standard surveying operations such as but not limited to: leveling, traversing, topographic mapping, construction layout, as-built surveys, boundary surveys, profile and cross section surveys.

- 3) *Survey Control* (B=5, C=5, O=5)
Know when to use, how to obtain, how to interpret control point records and data sheets, as well as create and locate points in the field.

- 4) *Survey Computations* (B=16, C=16, O=16)
Have extensive knowledge of trigonometry, geometry, and algebra as related to traverse, inverse and intersection computations. Be capable of performing horizontal and vertical traverse adjustments, area and quantity computations, and horizontal and vertical curve computations. An understanding of the State Plane Coordinate system and network adjustments is required. Knowledge of the reduction and checking of field notes for determination of positions and elevations. Have a knowledge of computer operating systems and GIS.
- 5) *Office Operations, Plan Reading and Preparation* (B=11, C=11, O=40)
Using hand calculations or computer software, be able to enter field data and produce positional information (i.e., leveling, traversing, as-built surveys, topographic mapping). Have a knowledge and understanding of plan reading and preparation (i.e., site plans, boundary plans, highway plans, profiles and cross sections, horizontal and vertical curves, pipeline plans, foundation plans, and developing existing and finish contours).
Know how to use Map Accuracy Standards. Have a knowledge and familiarity with general applications of computer aided drafting (CAD). Have knowledge of computer operating system and hardware peripherals.
- 6) *First Aid & Safety* (B=8, C=8, O=8)
Basic knowledge of treatment practices for a variety of medical emergencies. Have a general knowledge of traffic control and safety procedures for surveying and construction operations including Occupational Safety and Health Administration (OSHA) standards.
- 7) *Boundary Surveys* (B=15, C=4, O=4)
Know the fundamentals of establishment and retracement of property boundaries, land title issues and property ownership rights. Have a general familiarity with the legal principles of land ownership, land records and confliction title elements. General knowledge of easements, types of monuments and riparian rights is also expected
- 8) *Principles of the Profession* (B=5, C=5, O=5)
Have a knowledge of ethics and the various technical standards of groups such as ALTA, NGS, NSPS, ACSM, BLM, and ACSE. Show responsibility in the profession (i.e. attire, honesty, respect for personal property) and awareness of related professional associations
- 9) *Supervisory Skills* (B=7, C=7, O=7)
Have a basic knowledge and familiarity with: client contacts, dealing with the public and governmental agencies, field crew management, scheduling, equipment and supplies management. Have a knowledge of general company policies as they relate to field and office operations, office work flow procedures, and field and office problem solving techniques. Also have a knowledge of proper record keeping, time keeping, and job charges. Be able to coordinate and supervise field work, staking and stake marking for a variety of standard types for survey. Have a general familiarity with local and state and federal land use regulations as they relate to lot site development.

TOTAL NUMBER OF QUESTIONS = 110, TIME = 4 hours

CST LEVEL 3 SAMPLE TEST and Answer Guide

January 2023

Survey Types and History (2)

1. The number of the section that is directly South of section 13 in a standard township is
 1. 7
 2. 18
 3. 23
 4. 24

2. A more recent term that is now commonly being applied to encompass the areas of practice formerly identified as surveying is:
 1. Photogrammetry
 2. Geodetics
 3. Geomatics
 4. Global Positioning

Field Equipment and Operations (15)

3. A two-peg level test is performed with the instrument set up midway between two points, the rod reading on point 1 is 1.25 and the rod reading on point 2 is 10.76. The instrument is then moved close to point 1 and a reading on this point of 5.97. What should the reading be on point 2 for the line of sight to be parallel with the axis of the bubble tube?
 1. 6.04
 2. 10.76
 3. 15.48
 4. 17.98

4. From the bench mark notes shown below, what is the correct adjusted elevation for K13 in feet?

	Bench Mark Adjusted Elevation	
	(Meters)	(Feet)
• H 13	1083.738	3555.564
• I 13	1123.973	3687.568
• J 13	1036.042	3399.081
• K 13	1033.009	
• L 13	1024.866	3362.415

1. 3399.081
 2. 3099.027
 3. 3362.415
 4. 3389.130
5. When checking an EDM or total station against a calibration base line, the distances measured are compared to standard, known distances. The differences reflect:
1. Altitude Correction
 2. Atmospheric Correction
 3. System Measurement Correction
 4. Reflector Correction
6. If a tall structure is not vertical, there will be an error in transferring a control point from the:
1. bottom to the top
 2. left to the right
 3. right to the left
 4. instrument to the building windows
7. Manhole 39 is at station 100+00 and has an invert elevation of 100.00 feet. Manhole 40 is at station 105+00 and has an invert elevation of 75.00 feet. A 24-inch reinforced concrete pipe is laid on a straight grade between the two manholes. At station 104+00, the ground elevation is 90.00 feet. What is the cut, in feet, to the invert of the pipe at this location?
1. 10.00
 2. 20.00
 3. 40.00
 4. 100.00

8. To adjust the level bubble of a theodolite, the bubble is centered over one pair of leveling screws and then the instrument is rotated or reversed 180 degrees and the movement of the bubble from the centered position is noted. By means of the adjustment screws, the bubble is brought back how far toward the center position?
1. a quarter way back
 2. a third way back
 3. halfway back
 4. to the center position
9. A drainage ditch runs parallel with the centerline of a highway. The drainage ditch grade at station 120+00 is -5 percent and the elevation is 1614.00. At station 127+00 the ditch goes under the centerline of a side road, which requires a vertical clearance above the top of a 24" culvert. What is the clearance, in feet, if the side road elevation is 1584.50 feet?
1. 2.50'
 2. 3.00'
 3. 3.50'
 4. 4.00'
10. A rod reading is taken on a reference mark on a pile cutoff. The rod reads 3.13. A bench mark is then sighted and a reading of 11.89 is recorded. If the elevation of the bench is 2313.62, what is the elevation of the reference mark?
1. 2320.94
 2. 2322.38
 3. 2321.80
 4. 2304.86
11. While running true line down a property line a tree is directly online. A random traverse point was set at 1000.00 feet to the right of the tree at an angle of $0^{\circ} 02' 18''$. What is the calculated offset distance back to the property line at that random point?
1. 0.64'
 2. 0.66'
 3. 0.67'
 4. 1.32'
12. Given the following data for a circular curve on a set of highway plans, knowing that you need the stationing of the PC before you can calculate the station of the P.T., what is the stationing of the PT?

$$\begin{aligned}PI &= 1377+46.0 \\R &= 5729.59 \\ \Delta &= 16^\circ 45' \text{ LT} \\T &= 843.5 \\D &= 1^\circ 00' \\L &= 1675.0\end{aligned}$$

1. 1385 + 77.50
 2. 1369 + 02.53
 3. 1385 + 85.77
 4. 1385 + 89.55
13. A route survey of 1.86 miles was made for a new gas transmission line over rolling brushy terrain. If the open traverse is to conform to second order precision (class II), what is the maximum allowable error of length in measuring?
1. 9.80 feet
 2. 0.49 feet
 3. 4.91 feet
 4. 0.001 mile
14. While performing a topographic survey using a total station, what is NOT used in computing point elevations?
1. height of instrument
 2. horizontal angle
 3. target height
 4. zenith angle
15. Prism correction
1. increases as distance increases
 2. is determined by the configuration of the prism
 3. is not a factor in calibrating a total station
 4. varies with temperature
16. Which one of the following items would not be included in a set of traverse field notes?
1. date
 2. distances
 3. field crew personnel
 4. level serial number

17. A guardrail is to be staked along the westerly ROW of a highway that has a centerline bearing of North $20^{\circ} 15'$ West and is to run for 200 feet. The ROW is 166 feet in width, and the beginning centerline highway coordinates are N 50,650 and E 30,750. What are the centerline highway coordinates at the end of the guardrail?
1. N 50,837.64, E 30,680.78
 2. N 50,837.64, E 30,819.22
 3. N 50,719.22, E 30,562.37
 4. N 50,719.22, E 30,819.22

Survey Control (3)

18. If a series of differential levels were run from a FGCS third order U. S. bench mark a distance of 3000 feet and closed flat on a FGCS first order control station, what is the highest order of survey that could be attributed to the line or levels?
1. First
 2. Second
 3. Third
 4. Fourth
19. In using the State Plane coordinate System ground distance will _____ be less than the grid distance
1. always
 2. sometimes
 3. never
 4. along the Central Meridian
20. Geodetic distances are the same as
1. sea-level distances
 2. ellipsoid distances
 3. grid distances
 4. ground distances

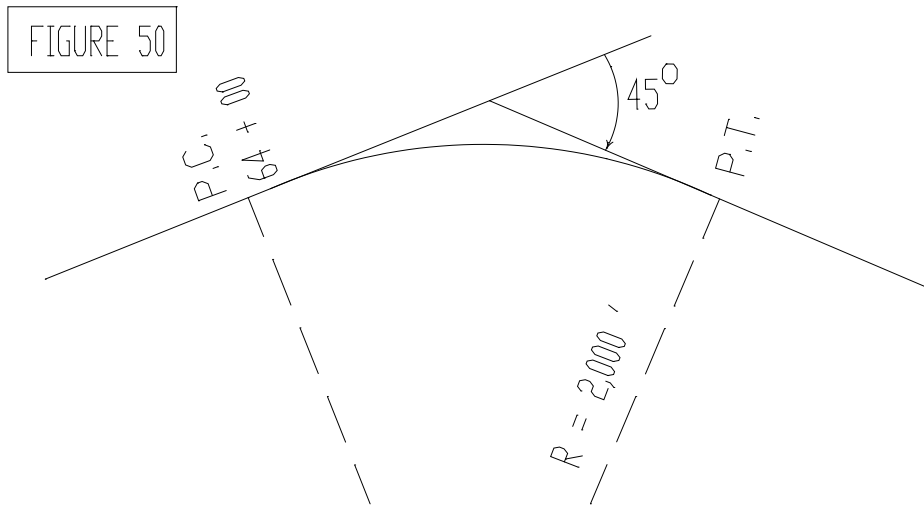
Survey Computations (8)

21. The notes for a three-wire level run from BM A TO BM B are shown for the two set-ups required. If elevation of BM A is 320.187, compute the elevation of BM B:

BS. 3.733, 2.657, 1.580
FS. 4.896, 3.824, 2.750
BS. 2.247, 1.185, 0.124
FS. 5.643, 4.630, 3.616

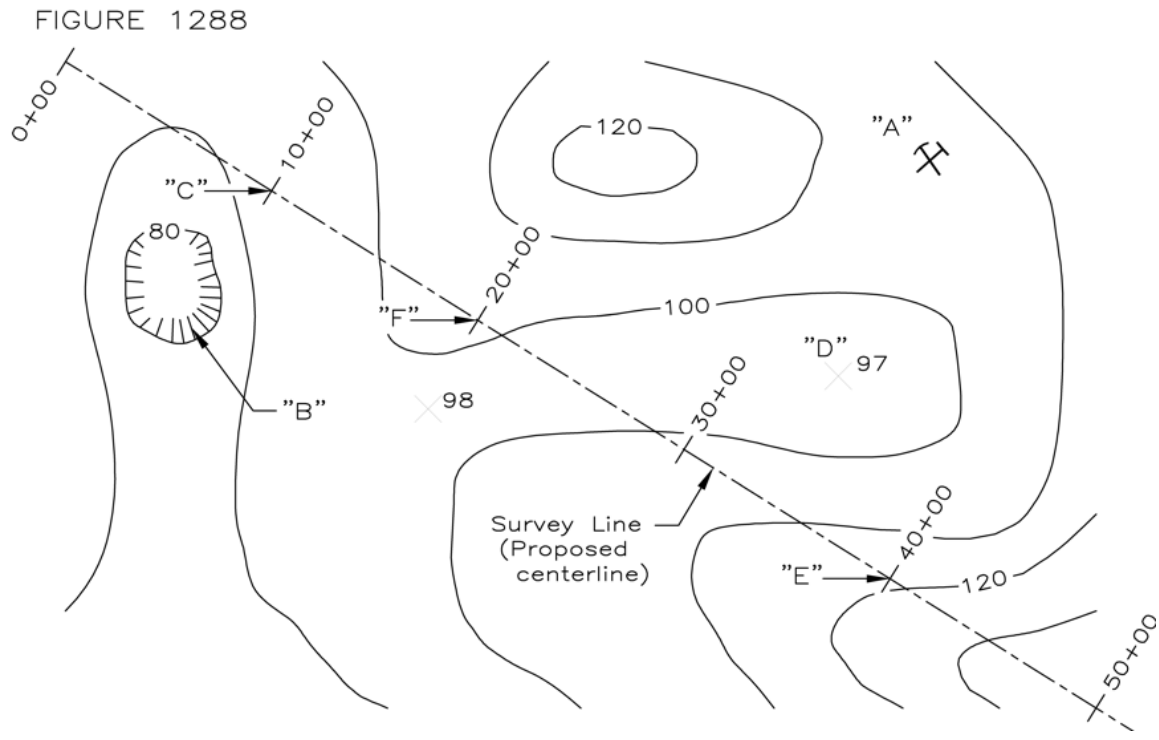
1. 315.575
 2. 315.576
 3. 315.579
 4. 315.580
22. A map has ten-foot contour lines on a uniform fill slope of 20:1. What ground distance would you measure for a vertical change of 10'?
1. 50'
 2. 100'
 3. 150'
 4. 200'
23. From point B, point A bears N 18° 26' 43" E, and point C bears S 4° 6' 21" E. What angle CBA is turned to the right from C to A?
1. 157° 26' 56"
 2. 202° 33' 04"
 3. 14° 20' 22"
 4. 165° 39' 38"

24. See Figure 50. What is the station of the P.T. of the circular curve to the nearest foot?
1. 64+00
 2. 70+00
 3. 72+28
 4. 79+71



25. You are staking a fence line starting at station $50+22.1$ and going to station $80+38.5$. There is an equation at $60+01.2$ BK = $58+90.6$ AHD. What length of fence (feet) is needed?
1. 3127.0
 2. 2147.9
 3. 3016.4
 4. 2905.8

26. See Figure 1288. If the slope of the proposed centerline is +1.0%, what is the elevation at 35+00 if the elevation of station 0+00 is 90 feet? (Round to the nearest foot.)
1. 135
 2. 130
 3. 128
 4. 125



27. If the daily rental cost of a piece of surveying equipment is 0.1% of its purchase price, what is the rental rate on an instrument costing \$9,500.00?
1. \$0.95 per day
 2. \$9.50 per day
 3. \$12.00 per day
 4. \$950.00 per day

28. If the State Plane Coordinate system combined (elevation and scale) factor is 0.99837552, what would be the grid distance for a measured ground distance of 1523.85 feet?
1. 1521.37
 2. 1524.85
 3. 1512.37
 4. 1522.33

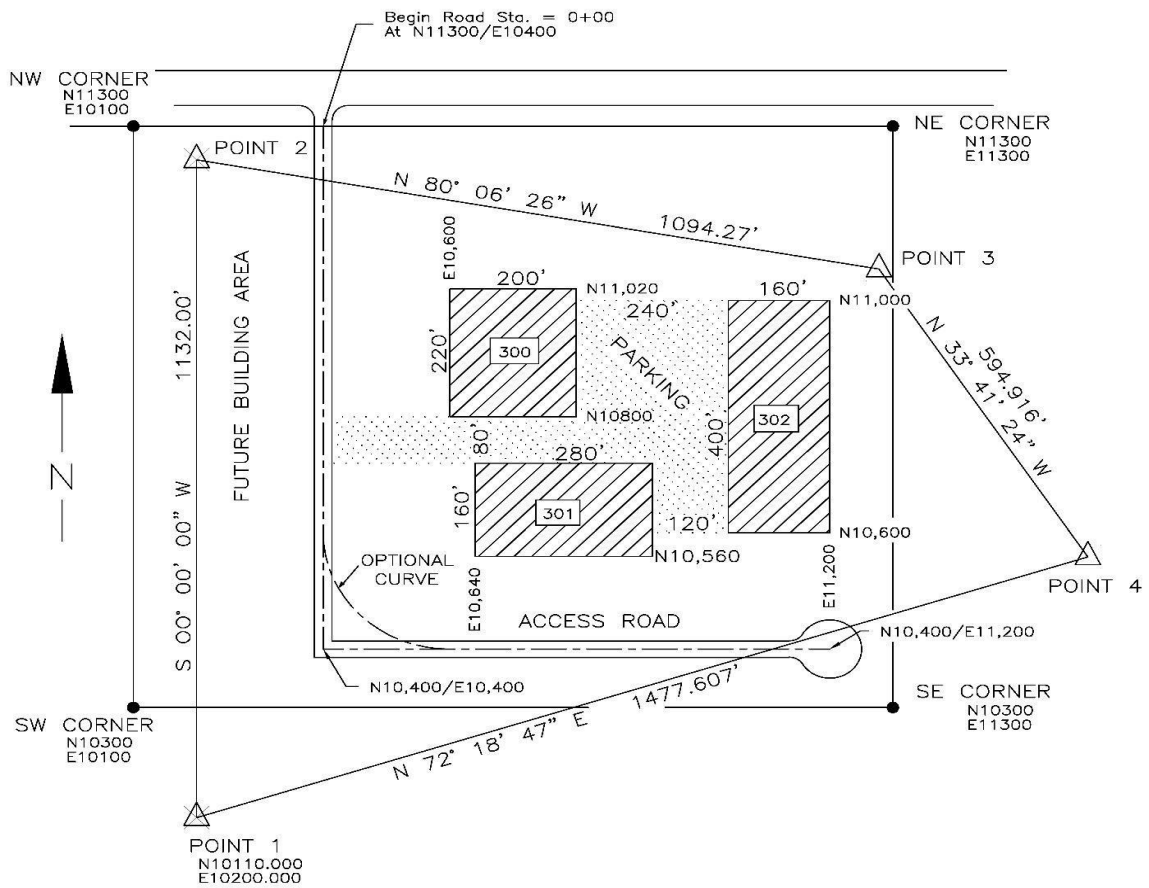
Office Operations, Plan Reading & Preparation (10)

29. A Plat is plotted at a scale of $1'' = 75'$. What change is needed to produce a drawing scale of $1'' = 100'$?
1. enlarge by 80%
 2. reduce to 80 %
 3. reduce to 75 %
 4. enlarge to 125%
30. Calculate the elevation of the centerline Station 19+50.50. Given $G1 = -3\%$, $G2 = +2.1\%$, $L = 400$, $PVI\ Sta = 19+00$, $PVI\ Elev = 127.31$.
1. 127.455
 2. 129.795
 3. 127.31
 4. 129.725
31. What is the length of the Arc for the following curve?
- | | |
|-------------|-------------|
| Radius | 600.00' |
| Tangent in | N 25° 30' E |
| Tangent out | N 30° 25' E |
1. 21.45
 2. 42.90
 3. 51.49
 4. 115.92

32. In Figure 1284, what would be the coordinates of the PC if the optional curves is used with a radius 200'?

1. N 10,400 E 10,400
2. N 10,400 E 10,600
3. N 10,200 E 10,300
4. N 10,600 E 10,400

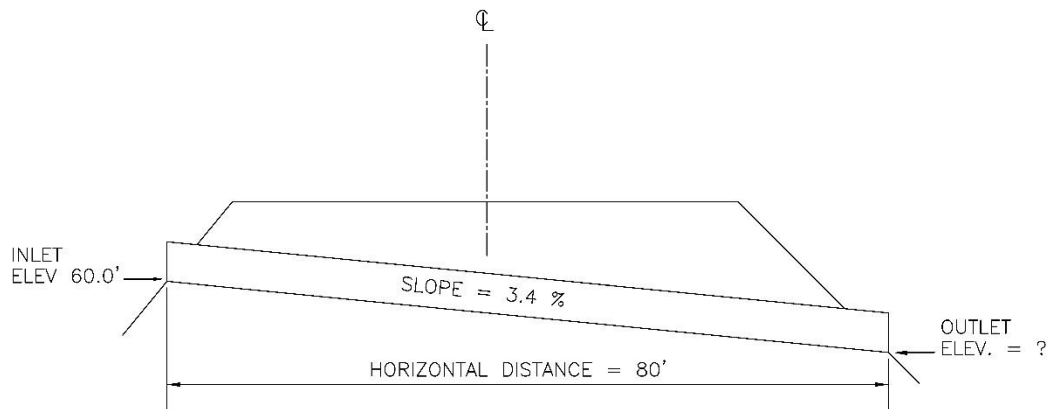
FIGURE 1284



33. See Figure 1284. The northeast corner of the boundary (property) is to be set at (N 11300, E 11300). What is the bearing and distance to this corner from point 3 if point 3 has a coordinate of (N 11053.999, E 11277.999)
1. N 05° 06' 38" E 246.98'
 2. N 06° 25' 38" W 246.98'
 3. N 15° 27' 00" E 247.00'
 4. S 05° 06' 38" E 246.98'
34. See Figure 1284. What is the station at the center of the cul de sac (without a curve)?
1. 8+50
 2. 12+75
 3. 17+00
 4. 21+70
35. At Sta. 10+50 the centerline elevation is 68.26 feet, the design cross slope is -2%, the distance from the centerline to curb is 40 feet and the curb is 6 inches high. What is the flow line elevation at the curb if the cross slope was changed to -1.50%?
1. 68.26'
 2. 67.26'
 3. 67.66'
 4. 68.86'
36. See Figure 30. The centerline elevation of the 60' road is 68.50'. What is the elevation of the top of the 30" CMP under the centerline? (Ignore pipe thickness). Road side slopes are 1:1.
1. 59.28
 2. 60.12
 3. 61.19
 4. 58.69

37. See Figure 30. If the inlet and outlet elevations of the pipe were found to be 60.0 feet and 59.3 feet respectively, the actual slopes of this pipe would be;
1. 0.8750%
 2. 0.010%
 3. 0.922%
 4. 0.902%

FIGURE 0030



38. Interpolation in topographic mapping means:
1. Connecting points of known elevation
 2. Drawing contour lines
 3. Drawing contour lines through fixed points
 4. Scaling and locating the contour points by proportion
39. Contours on a map show elevation at 20 foot intervals and the scale of the map is 1" = 400'. A measured distance between two contours is 1/2 inch. What is the percent of slope of the ground at that point?
1. 0.05%
 2. 1.00%
 3. 5%
 4. 10%

First Aid & Safety (4)

40. In the treatment of frostbite, all of the following are proper procedures for emergency first aid treatment EXCEPT one. Which one of the following should NOT be done?
1. rub the frozen part and warm with a hot water bottle
 2. give the victim a warm non-alcoholic drink
 3. bring the victim indoors as soon as possible
 4. immerse the frozen part in warm water
41. In first aid, which of the following injuries require the most immediate action?
1. shock
 2. sunstroke
 3. bleeding and stoppage of breathing
 4. heat stroke
42. Which of the following is NOT a correct first aid procedure for a victim of poisonous snakebite?
1. keep the victim calm and quiet
 2. keep the bitten part still
 3. give care for shock
 4. Apply tourniquet to control venom spread
43. If an employee is seriously injured while surveying, what action should be taken?
1. Have the victim see a doctor and then return to work.
 2. Administer first aid and have the victim return to work.
 3. Administer first aid and seek immediate medical care.
 4. Administer basic first aid, then send employee home.

Boundary Surveys (7)

44. Reliction is the term used to define the process:
1. of gradual recession of water leaving land permanently uncovered.
 2. of subdivision of a standard GLO Township
 3. of adjusting a spirit level by splitting the error and adjusting $\frac{1}{2}$ the error until the bubble does not change position
 4. of natural tidal accretions to uplands
45. After the monument for the northeast corner of a property was set as shown in figure 1284, it was discovered that the true property corner monument is N1.25 / E1.75 from the monument recently set. What procedure should be followed?
1. amend the survey drawing listing the original point as a reference.
 2. amend description to most recently set point.
 3. remove recently set corner and amend the survey drawing to show original corner.
 4. remove old corner.
46. You are performing a boundary survey for a client and discover a conflict between your client's property and the adjoining property owner. Your responsibility is to:
1. adjoining property owner.
 2. your client only
 3. both your client and the adjoiner
 4. the County Surveyor and the adjoiner
47. Accretion is the term used to define the process of:
1. The sudden separation of land by flooding.
 2. The gradual increase in land by the natural movement of water
 3. Land being uncovered a gradual subsidence of water.
 4. the value of land changing due to the gradual subsidence of water.

48. Two adjoining parcels overlap despite each having unambiguous descriptions. Both parcels were created from a single lot, one in 1952 and the other in 1955. Which statement is most likely correct?
1. The overlap must be proportioned between the two parcels
 2. The overlap remains with the original grantor of both parcels
 3. The overlap belongs to the parcel created in 1952
 4. The overlap belongs to the senior parcel unless the junior parcel is clearly monumented
49. In the deed course “thence South 120.00 feet to the north line of Ferry Street:”
1. The direction is informative and the distance is controlling.
 2. The distance is informative and the direction is controlling.
 3. The direction is informative and Ferry Street is controlling.
 4. Both the distance and the direction are controlling.
50. A surveyor's duty with respect to adverse possession:
1. includes selling the piece of land that is adversely possessed.
 2. includes showing possession and encroachments on his plat
 3. includes offering legal advice
 4. includes making adverse claims against the state

Principles of the Profession (2)

51. Which federal agency oversees the surveying method used while performing work in the "public land" states?
1. U.S.F.S.
 2. N.S.P.S.
 3. B.L.M.
 4. U.S.G.S.
52. In most cases, the public's perception of surveying is obtained by:
1. Observing a field crew in operation
 2. Observing personnel in the office
 3. Observing plans
 4. attending public hearings

Supervisory Skills (3)

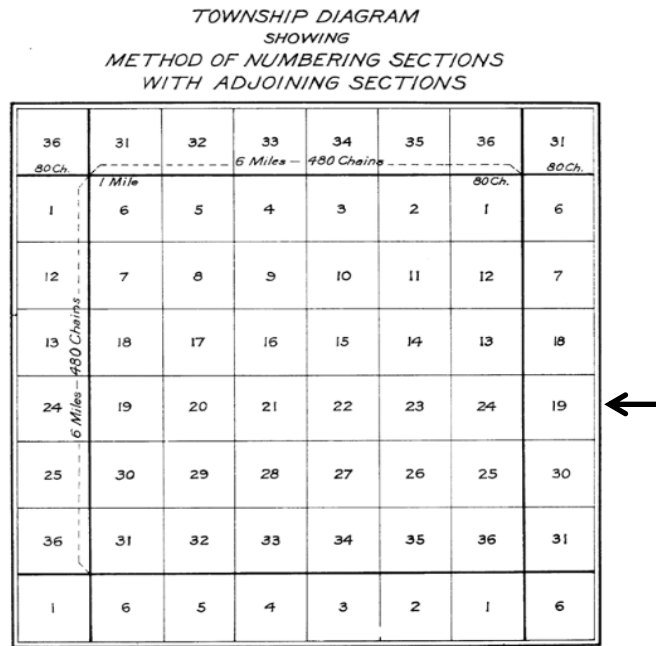
53. If an unruly crew member begins to be a danger to the crew you should first
1. Call an ambulance
 2. call the police
 3. call your supervisor
 4. ignore the person and continue to get the work done
54. One of the best methods of motivating a survey crew member is to:
1. emphasize the importance of the person's work
 2. provide good perks
 3. provide an adequate hospitalization plan
 4. provide sufficient disability insurance
55. the most important abilities that a party chief must have is
1. adequate first aid knowledge
 2. good communicative skills
 3. taking good care of equipment
 4. neat and thorough note taking

CST Level 3 Sample Test Answers & Guide

January 2023

Survey Types and History

1.) #4. 24

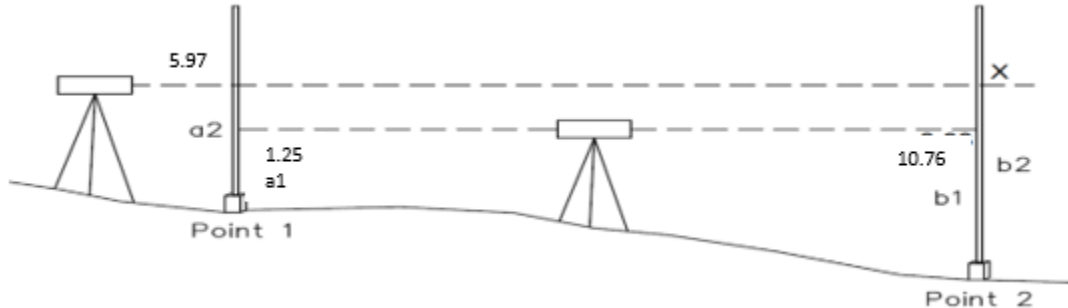


“Elementary Surveying: An Introduction to Geomatics”
13th Ed. Copyright 2012
Charles D. Ghilani, Paul R. Wolf (G & W)
Pearson Education, Inc.
Chapter 22 Surveys of the Public Lands
(Sub Chapter 22.11 Page 670)

2.) #3. Geomatics see G & W 14th, p 3

Field Equipment & Operations

3.) #3. 15.48



$$(a_2 - a_1) = (5.97 - 1.25) = 4.72 \text{ therefore } (10.76 + 4.72) = X \text{ and } X = 15.48$$

Also see:

“Elementary Surveying: An Introduction to Geomatics”

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Chapter 4 Leveling – Theory, Methods, and Equipment

(Sub Chapter 4.15.5 Pages 98-100)

4) #3 3389.130

$$1033.009 \text{ m} \times 3.2808333 \text{ ft./m} = 3389.130 \text{ ft.}$$

This would be a conversion between meters and the US Survey Foot

The conversion using the International foot (3.280839895 ft./m) yields an answer of 3389.137 ft.

Always be certain which conversion you need in a given situation.

(See G&W inside front cover for Conversion Factors)

5.) #3. The System Measurement Correction

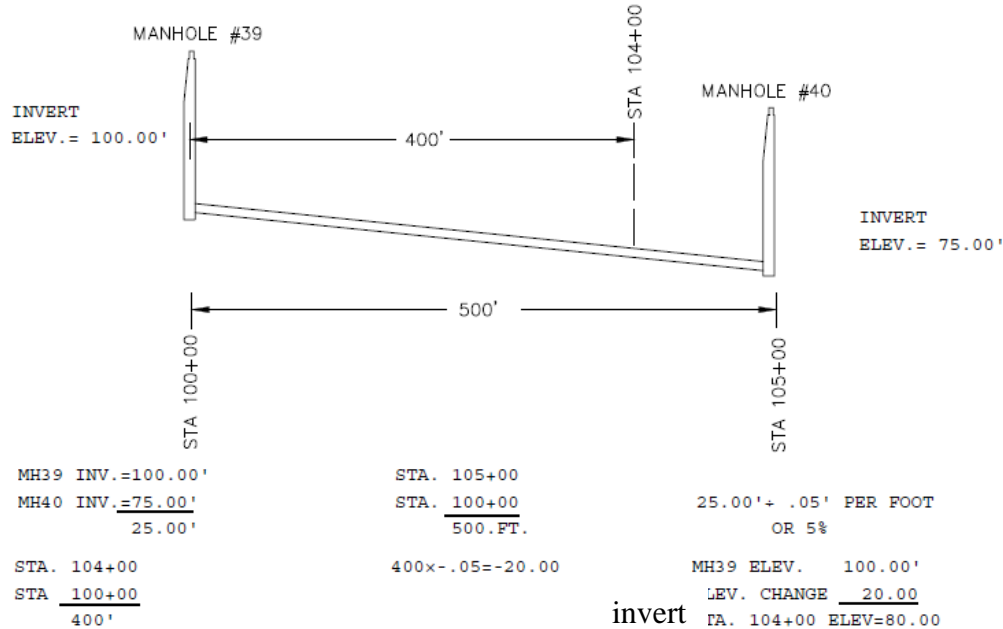
“Elementary Surveying: An Introduction to Geomatics”

14th Ed. Page 156

6.) #1. Bottom to top

Best answer among the possible choices. Choice #2 and 3 would relate to horizontal alignment and choice # 4 would not result in any control information.

7.) #1. 10.00



Ground elevation at Sta. 104+00 = 90.00

Cut required to invert at Sta. 104+00: 90.00 - 80.00 = 10.00 ft.

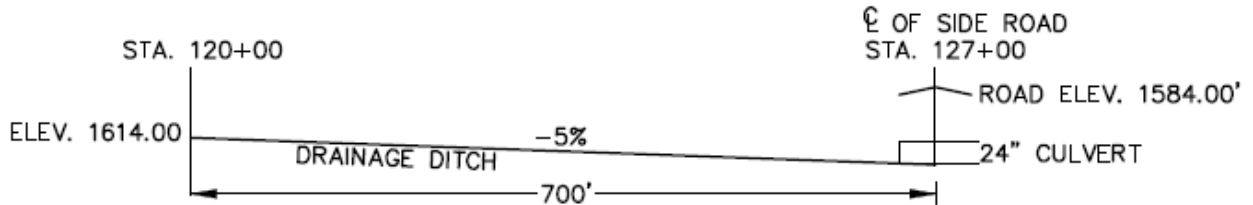
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Charles D. Ghilani, Paul R. Wolf
Pearson Education, Inc.
Chapter 23 Construction Surveys
(Sub Chapters 23.4 and 23.5 Pages 691-694)

8.) #3. halfway back see G & W 14th, p 212

Also:
“Elementary Surveying: An Introduction to Geomatics”
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Pearson Education, Inc.

Chapter 4 Leveling – Theory, Methods, and Equipment
 (Sub Chapter 4.15.3 Page 97)

9.) #3 3.50'



BEGINING DITCH C ELEV.=1614.00 ENDING STA. AT C SIDE ROAD=1584.00
 LENGTH X SLOPE= ELEV. DIFFERENCE
 $700 \times 0.05=35.00$
 $1614.00-35.00=1579.00$
 DITCH ELEV. OF 1579.00 + 24" CULVERT=1581.00 TOP OF CULVERT ELEV.
 ROAD ELEV. 1584.00

$$\begin{array}{rcl} \text{Road Elevation - Top of Culvert} & = & \text{clearance} \\ 184.50 & - & 1581.00 & = & 3.50 \end{array}$$

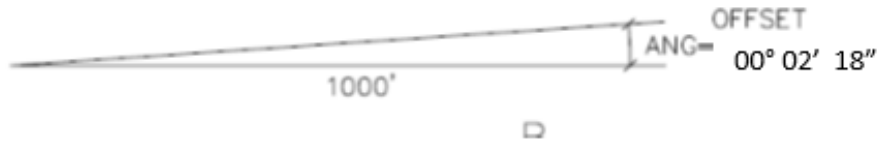
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 Chapter 23 Construction Surveys
 (Sub Chapter 23.4 Staking Out a Pipeline and 23.5 Staking Pipeline Grades Page
 691-694)

10.) #2 2322.38

$$\text{Elv. Of BM } 2313.62 + \text{BS of } 11.89 = \text{HI of } 2325.51$$

$$\text{HI of } 2325.51 - \text{reading on pile of } 3.13 = \mathbf{2322.38} \text{ the elevation of pile cutoff}$$

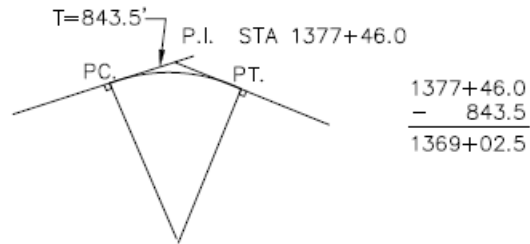
11.) #3 0.67'



$$\text{Sine } (0^\circ 02' 18'') \times 1000\text{ft} = 0.67 \text{ ft}$$

12) #1

1385+77.50



$$\text{PI station} - \text{Tangent Length} + \text{Curve Length} = \text{PT station}$$

$$1377+46.0 - 843.5 + 1675.0 = 1385_77.50$$

13) # 2 0.49 feet

Smallest permissible closure for a Second Order Class II survey is 1:20,000.

$$1.86 \text{ miles} = 9820.8 \text{ feet} \div 20,000 = 0.491 \text{ feet}$$

$$\frac{1}{20,000} = \frac{X}{9820.8} \quad X = \frac{9820.8}{20,000} \quad X = 0.491 \text{ ft.}$$

“Standards and Specifications for Geodetic Control Networks”
 Federal Geodetic Control Committee
 Rockville, Maryland
 September 1984
 Section 3. Specifications
 (Sub-section 3.3 Traverse Pages 3-3 thru 3-4)

14) #2 horizontal angle

See G & W 14th, p 77 Eq 4.10

$$\Delta \text{ elev} = h_i + s \cos Z - r$$

h_i = height of instrument

s = slope distance

Z = zenith angle

R = target height

15) #2 is determined by the configuration of the prism

See G & W 14th, p 155

16) #4 A level is not used in a traverse

17) #1 N 50,837.64, E 30,680.78

$$\Delta X = (200) (\text{Sine } 20^\circ 15') = -69.22'$$

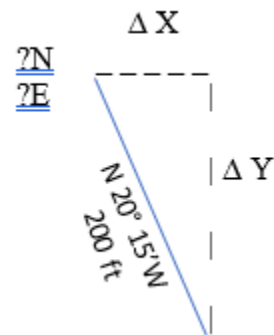
$$\Delta Y = (200) (\text{Cos } 20^\circ 15') = 187.64'$$

$$?N = 50,650 + 187.64 = N 50,837.64$$

$$?Y = 30,750 - 69.22 = E 30,680.78$$

$$N 50,650$$

$$E 30,750$$



Survey Control

18) Third

Even though the level circuit closed with zero error, since it was tied into a third order point, its order cannot improve the order of the point it is tied into

19) #2 sometimes

The Grid factor can sometimes be less than 1 or greater than 1

See G & W 14th, p 603

20) #2 ellipsoid distances

See G & W, p 604, fig. 20.8

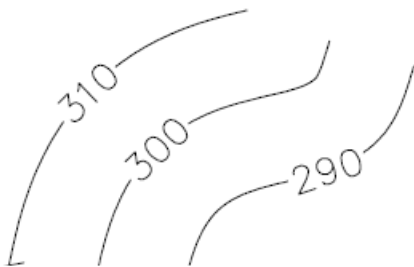
Survey Computations

21) #2 315.576

Sta.	Sight	Sight	Elev.
BM A			320.187
	3.733	4.896	
	2.657	3.824	2.6567
	<u>1.580</u>	<u>2.750</u>	322.8437
	7.970	11.470	-3.8233
Average	.2.6567	3.8233	
TP1			319.0204
	2.247	5.643	
	1.185	4.630	1.1853
	<u>0.124</u>	<u>3.616</u>	320.2057
Average	3.556	13.889	-4.6297
BM B	1.1853	4.6297	315.5760

“Elementary Surveying: An Introduction to Geomatics”
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 Chapter 5 Leveling – Field Procedures and Computations
 (Sub Chapter 5.8 Three-Wire Leveling Pages 115-116)

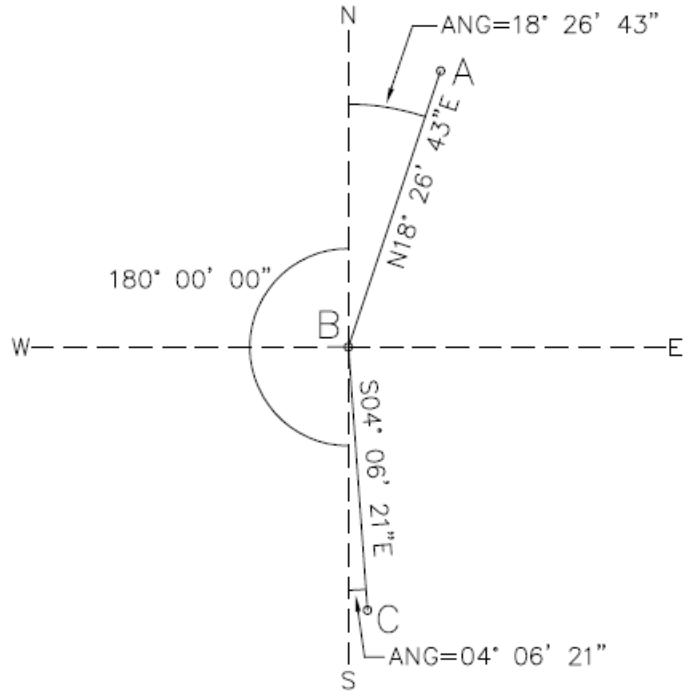
22) # 4 200'



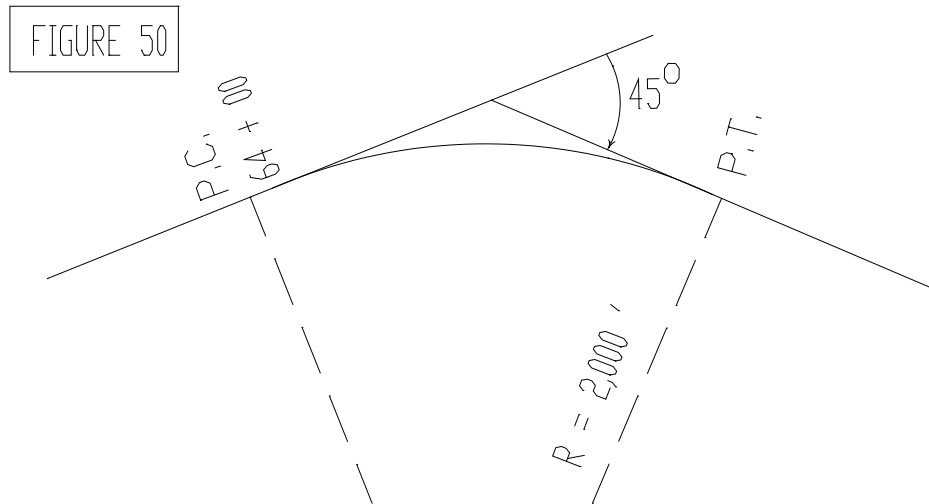
20:1 FILL SLOPE
 200' BETWEEN 10' CONTOURS
 IF 1"=40', THEN
 $200' \div 40' = 5"$

#23) # 2 202° 33' 04"

$$18^{\circ} 26' 43'' + 180^{\circ} + 4^{\circ} 06' 21'' = 202^{\circ} 33' 04''$$



24) #4 79+71



(D) degree of curve = $5729.58/R$ so $5729.58/2000 = 2.86479^\circ$

(L) length of curve = $100 (I/D)$ so $100 (45^\circ/2.86479^\circ) = 1570.79$

P.C. Sta. + Length of curve (L) = P.T. Sta.

$64+00 + 15+70.79 = 79+71 = \text{PT Sta.}$

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Chapter 24 Horizontal Curves

(Sub Chapter 24.4 Circular Curve Stationing Page 720-721)

25) # 4 2905.8

Station equation : $60+01.2 \text{ BK} = 58+90.6 \text{ AHD}$ means there is a change in the stationing of $6001.2 - 5890.6 = 110.6 \text{ ft}$

So, the total length of the fencing needed would be:

$8038.5 - 5022.1 - 110.6 = 2905.8 \text{ ft.}$

26) # 4 125

Raise in grade from 0+00 to 35+00: $3500\text{ft} \times 1\text{ft}/100\text{ft} = 35 \text{ ft}$

Elev. Sta. 0+00 = 90 ft so Elev. of Sta. 35+00 = $90 + 35 = 125 \text{ ft.}$

27) # 2 \$9.50 per day

$$\text{Daily cost} = 0.1\% \text{ of } \$9,500 \text{ Or } .001 \times \$9,500 = \$9.50/\text{day}$$

28) #1 1521.37

$$\begin{aligned} \text{Ground distance} \times \text{Combined Factor} &= \text{Grid distance} \\ 1523.85 \times 0.99837552 &= 1521.37 \end{aligned}$$

G & W 14th, p 605 (eq 20.53)

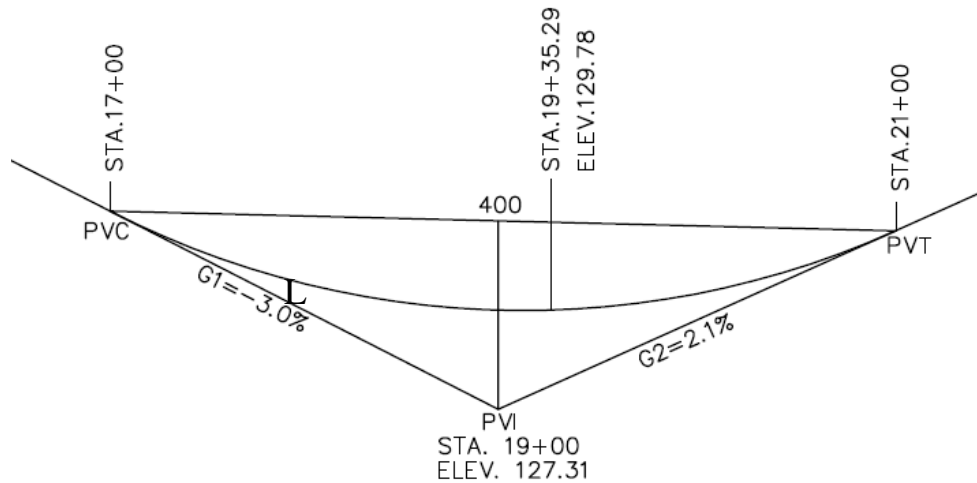
Office Operations, Plan Reading and Preparation

29) #3 Reduce to 75%

$$(\text{Original Scale/Desired Scale}) \times 100 = \text{Enlargement or Reduction Percentage}$$

$$(75/100) \times 100 = 75\%$$

30) # 2 129.795



DISTANCE FROM PVC TO LOW POINT IN STATIONS

$$X = \frac{G_1(L)}{G_1 - G_2} \quad X = \frac{-.03(4)}{-.03 - .021} \quad X = 2.3529 \text{ STA.}$$

ELEVATION OF ANY POINT ON CURVE

$$Y = Y_{\text{BVC}} + G_1 + \left(\frac{G_2 - G_1}{2L} \right)$$

$$Y = 133.31 + (-0.03)235.29 + \left(\frac{0.021^2(-.03)}{(2)400} \right) 235.29$$

$$Y = 129.78$$

Elevation of beginning of curve:

$$Y_{pvc} = 127.31 + (3) * 2.0 \text{ stations} = 127.31 + 6 = 133.31$$

Elevation of any point on curve $Y_p = Y_{bvc} + (G1)(X) + \frac{r(X^2)}{2}$

(See B&W 14th, p 751, eqns. 25.4 and 25.5)

$$\text{Where } r = (G2 - G1)/L = ((2.1) - (-3))/4 = 5.1/4 = 1.275$$

So for station 19+50.50, $X = 2+50.50$ or 2.5050 stations

$$Y_{19+50.50} = 133.31 + (-3)(2.5050) + \frac{(1.275)(2.5050)^2}{2}$$

$$= 133.31 + (-7.515) + 4.0003$$

$$= 125.795 + 4.000 = 129.795$$

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Chapter 25 Vertical Curves

(Sub Chapter 25.4 Pages 761)

31) # 3 51.49

$$\Delta, \text{ deflection angle} = N 30^\circ 25'E - N 25^\circ 30'E = 4^\circ 55' = 4.91666^\circ$$

$$L, \text{ length of curve} = 100 (\Delta/D)$$

$$D, \text{ degree of curve} = 5729.58/\text{Radius} = 5729.58/600 = 9.5493^\circ$$

$$\text{So } L = 100 (4.91666/9.5493) = 51.49 \text{ ft}$$

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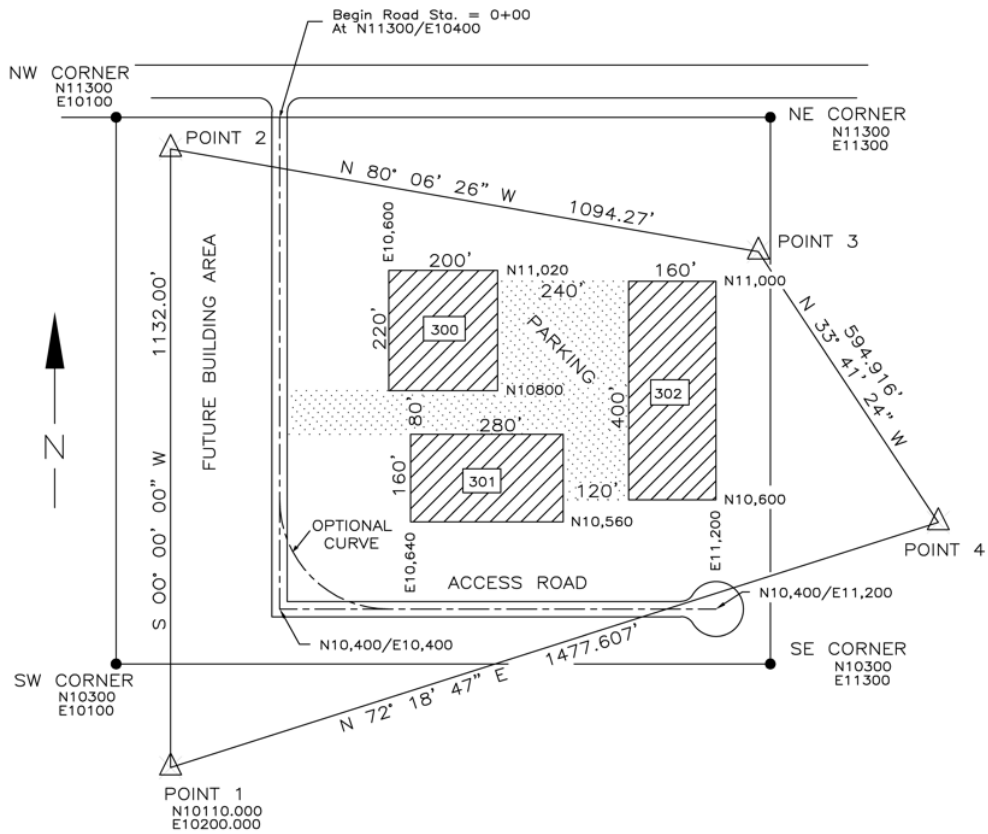
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Chapter 24 Horizontal Curves

(Sub Chapters 24.2 and 24.3 Pages 716-719)

32) #4 N 10,600 E 10,400

FIGURE 1284



Length of west leg of roadway: $\Delta N = 11,300 - 10,400 = 900\text{ft}$
 $\Delta E = 10,400 - 10,400 = 0$

For a curve with a radius of 200 ft and a Δ angle of 90°

$$\text{Tangent Distance} = R (\tan I/2) = 200' (\tan 45^\circ) = 200'$$

So PC station will be 200' back from end of west leg

$$N = 10,400 + 200 = \mathbf{10,600}$$

$$E = \mathbf{10,400}$$

33) # 1 N 05° 06' 38" E 246.98'

Point 3 to NE prop. Corner $\Delta N = 11,300 - 11,053.999 = 246.001'$
 $\Delta E = 11,300 - 11,277.999 = 22.001'$

Bearing 3-PC = $\text{Tan}^{-1} (\Delta E/\Delta N) = \text{Tan}^{-1} (22.001/246.001) = 5.110627958^\circ$
 $= 5^\circ 06' 38''\text{NE}$

Length of distance P3 to PC = $(\Delta X^2 + \Delta Y^2)^{1/2} = (22.001^2 + 246.001^2)^{1/2} = 246.98'$

34) # 3 17+00

West leg of road is due south $\Delta N = 11,300 - 10,400 = 900$ ft

South leg of road is due east $\Delta E = 11,200 - 10,400 = 800$ ft

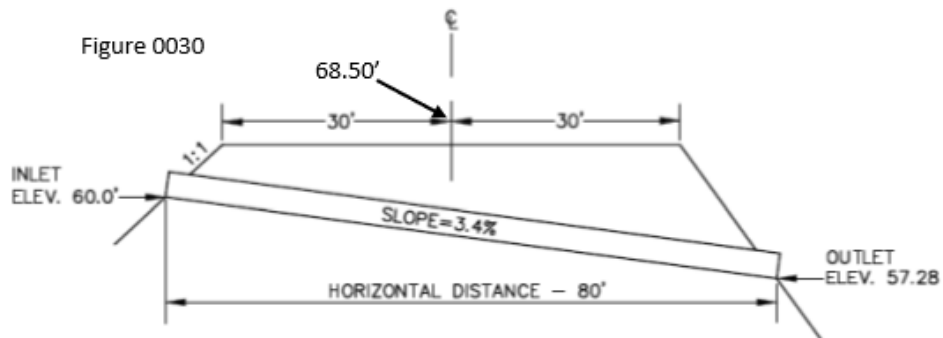
So, total length of road (with no curve) is $900 + 800 = 1700'$ so Sta 17+00

35) # 3 67.66'

Cross slope of $(-1.5\%) \times (40')$ = grade change of $-0.60'$

So flow line elevation would be CL elev – grade change
 $68.26' - 0.60' = 67.66'$

36) #3 61.19



Road Elev. = 68.50' Left slope at 1:1 adds 8.5 to the distance from centerline

Inlet Elev. = 60.00' and the Pipe inlet is 38.5' left of centerline

So the Invert Elev. at CL = Inlet Elev. – $(38.5' \times \text{slope})$

$$60.0' - (38.5' \times .034) = 58.69'$$

And so the CL Elevation of the top of the 30" CMP (ignoring pipe thickness)

$$= 58.69' + 2.5' = 61.19'$$

37) # 1 0.875%

Slope of pipe = $(60.0 - 59.3)/80' = 0.7/80 = 0.00875$ or 0.875%

38) # 4 Scaling and locating the contour points by proportion

See G & W, p 507

39) # 4 10%

0.5 inches at 1" = 400' scale would represent 200 ft

A change in elevation of 20' in 200 ft would be a slope of $20/200 = 0.1$ ft/ft or 10%

First Aid and Safety

40) #1 rub the frozen part and warm with a hot water bottle

Soak for 20 to 30 minutes or until the skin becomes its normal color or loses its numbness. For the face or ears, apply a warm, wet washcloth. Don't rewarm frostbitten skin with direct heat, such as a stove, heat lamp, fireplace or heating pad.

Frostbite: First aid - Mayo Clinic

41) # 3 bleeding and stoppage of breathing

What has the highest priority for the first aider?

The priorities therefore is aimed at firstly **getting oxygen into the blood stream**, ensuring that the blood is circulating around the body, and then preventing the loss of that blood. Priority number one then with any patient is to make sure the Airway is open and then to check they are breathing normally.

Emergency First Aid – Priorities of Treatment - Blake Training

42) # 4 Apply tourniquet to control venom spread

<https://www.cdc.gov/niosh/topics/snakes/symptoms.html>

Do NOT do any of the following:

- Do not pick up the snake or try to trap it. NEVER handle a venomous snake, not even a dead one or its decapitated head.
- Do not wait for symptoms to appear if bitten, get medical help right away.
- Do not apply a tourniquet.
- Do not slash the wound with a knife or cut it in any way.
- Do not try to suck out the venom.
- Do not apply ice or immerse the wound in water.
- Do not drink alcohol as a painkiller.
- Do not take pain relievers (such as aspirin, ibuprofen, naproxen).
- Do not apply electric shock or folk therapies.

43) #3 Administer first aid and seek immediate medical care

Since it is a "serious injury", returning to work is not an option.
Since it is "serious", simply going home after basic first aid administration is unwise.

Boundary Surveys

44) #1 of gradual recession of water leaving land permanently uncovered

See Definitions of Surveying and Associated Terms
Revised Edition 2005, American Congress on Surveying and Mapping
Page 217.

45) # 3 remove recently set corner and amend the survey drawing to show original corner

When evidence shows that a monument was set in an incorrect location all efforts should be expended to correct the error, both in the field monumentation and the record documents.

46) # 3 both your client and the adjoiner

A land surveyor's first responsibility is to protect the public and your next duty is to the profession and then to your client.

47) # 2 The gradual increase in land by the natural movement of water.

See Definitions of Surveying and Associated Terms
Revised Edition 2005, American Congress on Surveying and Mapping
Page 8.

48) # 3 The overlap belongs to the parcel sold in 1952

The parcel that was created first has "senior" rights. Even if the junior parcel was monumented per the description, there is an overlap and the senior parcel's location is controlling.

49) # 3 The direction is informative and Ferry Street is controlling

The calls in a deed have a certain order of importance in the case of conflicting title elements.

Brown's Boundary Control and Legal Principles, 5th Edition, page 307 lists them and a call for a monument governs over bearings and distance calls. So the call for "Ferry Street" is an artificial monument and thus governs or "controls".

50) # 2 includes showing possession and encroachments on his plat

Since the land surveyor's primary duty is to the protection of the public, and the determination of adverse possession is a question for the courts, the best answer is to show the evidence that has been uncovered in the survey on the plat.

Principles of the Profession

51) #3 B.L.M.

Of the listed agencies, only the Bureau of Land Management has the role of overseeing survey methods in the "public lands" states

See Definitions of Surveying and Associated Terms
Revised Edition 2005, American Congress on Surveying and Mapping
Page 37.

52) # 1 Observing a field crew in operation

The general public seldom sees the work performed in the surveying office, and very few see survey plans or attend public hearings, but they do often see the field crews while driving.

Supervisory Skills

53) # 3 call your supervisor

Of the choices offered, the best answer is “call your supervisor”. That person has the obligation to advise you on what to do, after you explain the situation.

54) # 1 emphasize the importance of the person's work

While rewards and the other suggested perquisites are important for employees, the recognition of the importance of the individual for the firm (and praise for accomplishments) is usually listed as one of the primary ways to motivate employees.

55) # 1 adequate first aid knowledge

While all of the options are important, the MOST important would be first aid knowledge both for the benefit of the employees and the protection of the company from liability.