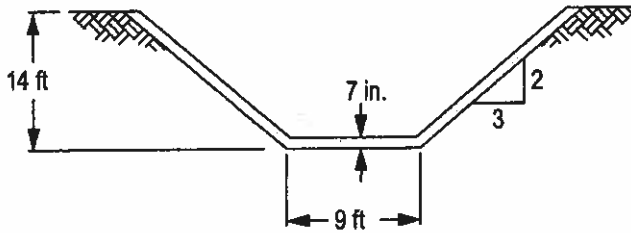


## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

1. A 227-ft length of canal is to be lined with concrete for erosion control. With 12% allowance for waste and overexcavation, the volume ( $\text{yd}^3$ ) of concrete that must be delivered is most nearly:

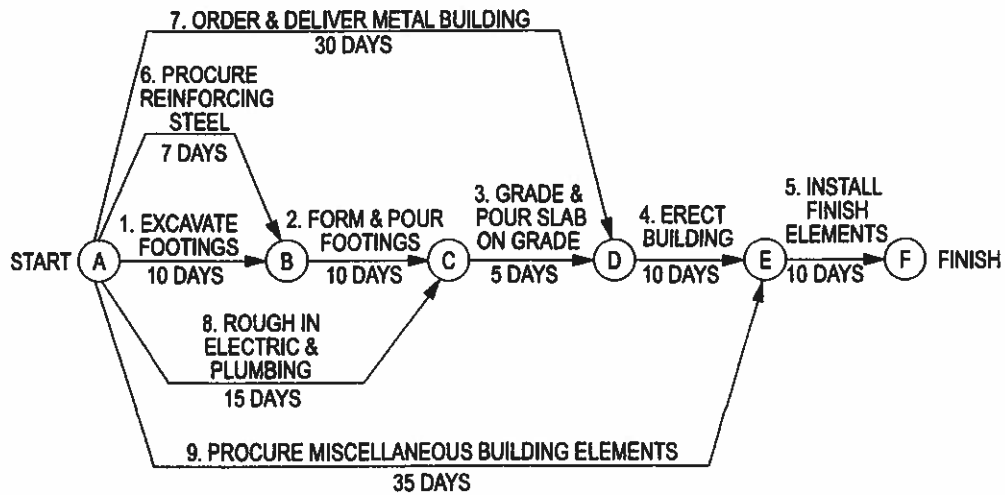


LINED LENGTH = 227 ft

- A. 234
- B. 280
- C. 292
- D. 327
2. A track loader has an initial cost of \$75,000 and a salvage value of \$10,000 at the end of its expected life of 10 years. Based on the straight-line method of depreciation, at the end of the track loader's 8th year, its book value is most nearly:
- A. \$10,000
- B. \$15,000
- C. \$23,000
- D. \$48,750
3. The budgeted labor amount for an excavation task is \$4,000. The hourly labor cost is \$50 per worker, and the workday is 8 hours. Two workers are assigned to excavate the material. The time (days) available for the workers to complete this task is most nearly:
- A. 3
- B. 4
- C. 5
- D. 12.5

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

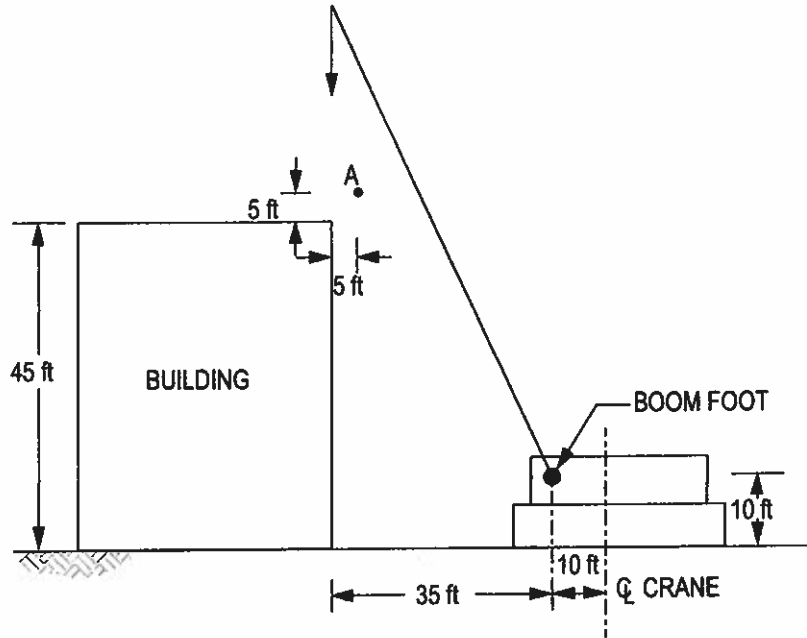
4. A CPM arrow diagram is shown below. Nine activities have been estimated with durations ranging from 5 to 35 days. The minimum time (days) required to finish the project is most nearly:



- A. 40
  - B. 42
  - C. 45
  - D. 50
5. A bridge is to be jacked up to replace its bearings. The design requires a hydraulic ram with a minimum capacity of 1,000 kilonewtons (kN). The hydraulic rams that are available are rated in tons (2,000 lb/ton). The **minimum** size (tons) ram to use is most nearly:
- A. 1,110
  - B. 250
  - C. 150
  - D. 100

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

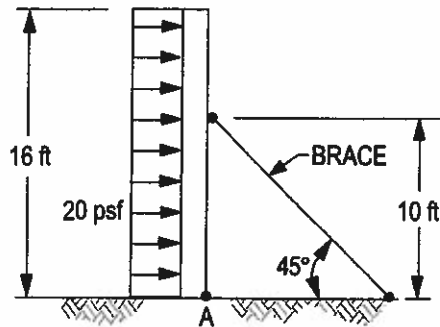
6. A crane with a 100-ft boom is being used to set a small load on the roof of the building shown. The minimum standoff (Point A) from the corner of the building to the centerline of the boom is indicated. What is the maximum distance (ft) from the edge of the building that the load can be placed on the roof?



- A. 16
- B. 25
- C. 30
- D. 36

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

7. A wall form subjected to a wind load of 20 psf is prevented from overturning by diagonal braces spaced at 8 ft on center along the length of the wall form as shown in the figure. The connection at the base of the form at Point A is equivalent to a hinge. Ignore the weight of the form. The axial force (lb) resisted by the brace is most nearly:



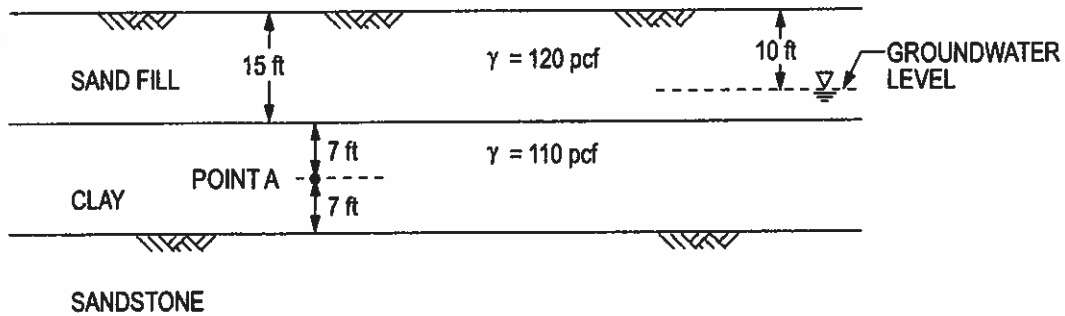
- A. 2,050
  - B. 2,560
  - C. 2,900
  - D. 4,525
8. Which one of the following statements regarding lateral earth pressures is correct?
- A. The lateral strain required to fully mobilize the soil passive pressure is considerably smaller than the lateral strain required to fully mobilize the soil active pressure.
  - B. The lateral strain required to fully mobilize the soil passive pressure is slightly smaller than the lateral strain required to fully mobilize the soil active pressure.
  - C. The lateral strain required to fully mobilize the soil passive pressure is slightly larger than the lateral strain required to fully mobilize the soil active pressure.
  - D. The lateral strain required to fully mobilize the soil passive pressure is considerably larger than the lateral strain required to fully mobilize the soil active pressure.

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

9. Site preparation and grading require the placement of 20 ft of new fill. An analysis of the resulting consolidation of the underlying soft, saturated, compressible deposits reveals a mean consolidation settlement of 22 in. affecting a 21.5-acre area. Prefabricated wick drains will be used to accelerate the settlement to meet the project schedule. Because of contamination from the former site use, the effluent from the wick drains must be collected and treated prior to disposal at an estimated cost of \$0.25 per gallon. Assume no loss of effluent during collection. The estimated treatment and disposal cost for the wick drain effluent at this site is most nearly:

- A. \$430,000
- B. \$3,200,000
- C. \$5,200,000
- D. \$35,000,000

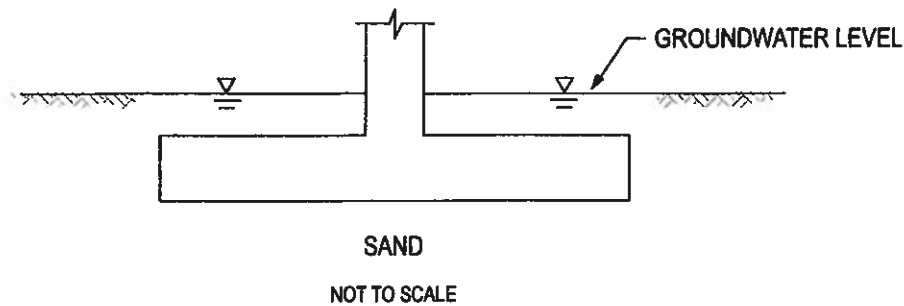
10. A soil profile is shown in the figure. The effective vertical stress (psf) at Point A is most nearly:



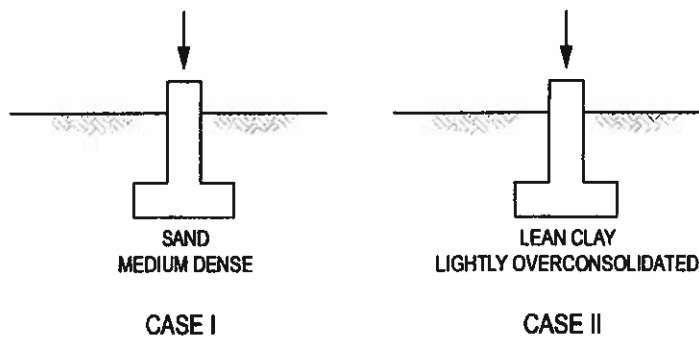
- A. 1,270
- B. 1,820
- C. 2,140
- D. 2,570

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

11. A bridge footing is to be constructed in sand. The groundwater level is at the ground surface. The ultimate bearing capacity is based on what type of soil unit weight?



- A. Buoyant unit weight
  - B. Saturated unit weight
  - C. Dry unit weight
  - D. Total unit weight
12. The figure shows two identical building footings with the same load but constructed in two different soil types. Which of the following statements is most correct?



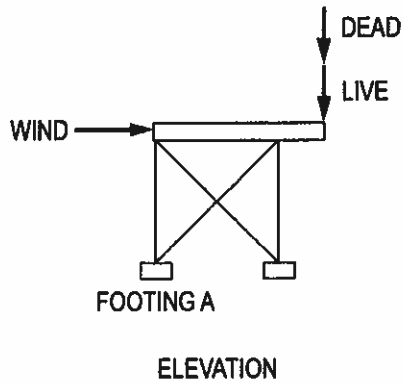
- A. The long-term settlement for Case I is less than Case II.
- B. The long-term settlement for Case II is less than Case I.
- C. The long-term settlements are the same for both cases.
- D. Settlement is not a concern for either case.

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

13. The minimum factor of safety against rotational failure for permanent slopes under long-term, nonseismic conditions influencing occupied structures is closest to:

- A. 1.0
- B. 1.1
- C. 1.5
- D. 3.0

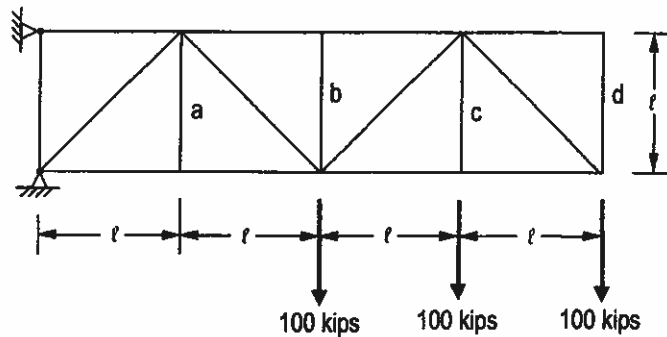
14. In the figure below, what load combination produces the maximum uplift on Footing A?



- A. Dead
- B. Dead + live
- C. Dead + wind
- D. Dead + live + wind

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

15. A simply supported truss is loaded as shown in the figure. The loads (kips) for Members b and c are most nearly:

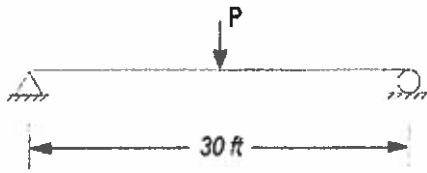


- A. Member b = 0  
Member c = 0
  - B. Member b = 0  
Member c = 100
  - C. Member b = 100  
Member c = 0
  - D. Member b = 100  
Member c = 100
16. Consider two beams with equal cross sections, made of the same material, having the same support conditions, and each loaded with equal uniform load per length. One beam is twice as long as the other. The maximum bending stress in the longer beam is larger by a factor of:
- A. 1.25
  - B. 2
  - C. 3
  - D. 4



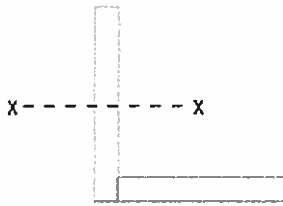
**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

17. The point load (kips) placed at the centerline of a 30-ft beam that produces the same maximum shear in the beam as a uniform load of 1 kip/ft is most nearly:

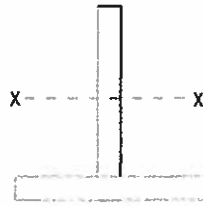


- A. 7.5
- B. 15
- C. 30
- D. 60

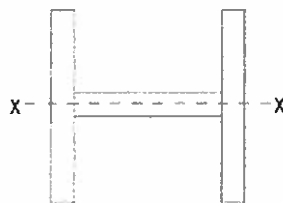
18. The beam sections shown are fabricated from 1/2-in.  $\times$  6-in. steel plates. Which of the following cross sections will provide the greatest flexural rigidity about the x-axis?



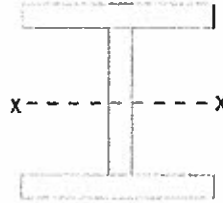
**Option A**



**Option B**



**Option C**

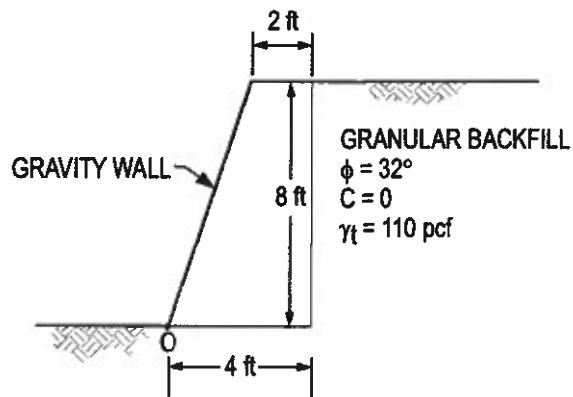


**Option D**

- A. Option A
- B. Option B
- C. Option C
- D. Option D

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

19. A concrete gravity retaining wall having a unit weight of 150 pcf is shown in the figure. Use the Rankine active earth pressure theory and neglect wall friction. The factor of safety against overturning about the toe at Point O is most nearly:



- A. 3.1
- B. 2.5
- C. 2.2
- D. 0.3
20. A drainage basin produces a stormwater runoff volume of 25.0 acre-ft, which must be drained through a rectangular channel that is 4 ft wide and 2 ft deep and has a uniform slope of 0.2%. Assume a Manning roughness coefficient of 0.022 and a constant depth of flow of 1.5 ft. The time (hours) it will take to discharge the runoff is most nearly:
- A. 12.5
- B. 16.4
- C. 18.5
- D. 25.0

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

21. Two identical 12-in. storm sewers flow full at a 2% slope into a junction box. A single larger pipe of the same material and slope flows out of the box. Assume the following pipe sizes are commercially available. The minimum size (in.) of this downstream pipe designed to flow full is most nearly:

- A. 16
- B. 18
- C. 20
- D. 24

22. The following table represents the rainfall recorded from all rain gauges located in and around a drainage area:

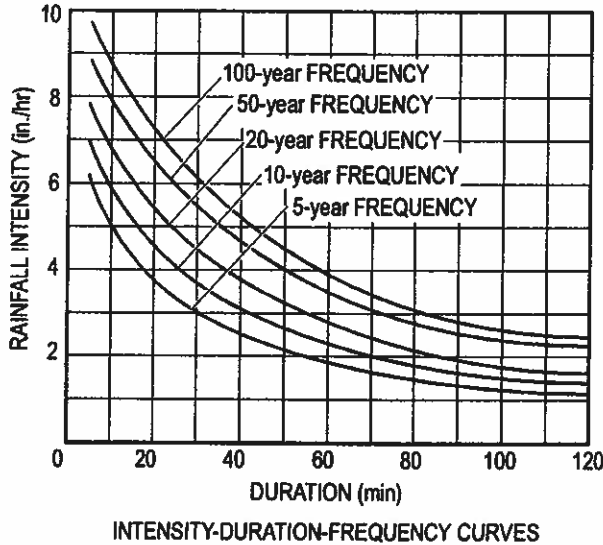
Gauge	A	B	C	D	E	F	G	H	I	J	K
Rainfall (in.)	2.1	3.6	1.3	1.5	2.6	6.1	5.1	4.8	4.1	2.8	3.0

Use the arithmetic mean method. The average precipitation (in.) for the drainage area is most nearly:

- A. 3.4
- B. 3.7
- C. 4.1
- D. 37.0

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

23. The rational method must be used to determine the maximum runoff rate for a 90-acre downtown area. The time of concentration for the 50-year frequency storm is 1 hour. Intensity-duration-frequency curves and a table of runoff coefficients are provided. The maximum runoff rate (cfs), based on the maximum runoff coefficient for a 50-year storm, is most nearly:



- A. 160
- B. 220
- C. 300
- D. 340

Description of Area	Runoff Coefficients
Business	
Downtown areas	0.70–0.95
Neighborhood areas	0.50–0.70
Residential	
Single-family areas	0.30–0.50
Multiunits, detached	0.40–0.60
Multiunits, attached	0.60–0.75
Residential (suburban)	0.25–0.40
Apartment dwelling areas	0.50–0.70
Industrial	
Light areas	0.50–0.80
Heavy areas	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35
Railroad yard areas	0.20–0.40
Unimproved areas	0.10–0.30
Streets	
Asphalt	0.70–0.95
Concrete	0.80–0.95
Brick	0.70–0.85
Drives and walks	0.75–0.85

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

24. A stormwater drainage ditch with a maximum capacity of 10 cfs discharges into a detention basin. The detention basin volume is 400,000 gal. During a storm event, the average discharge into the detention basin was 1.5 cfs. The time (hours) to fill the empty basin is most nearly:

- A. 1.5
- B. 9.9
- C. 11.1
- D. 74.1

25. Assume fully turbulent flow in a 1,650-ft section of 3-ft-diameter pipe. The Darcy–Weisbach friction factor  $f$  is 0.0115. There is a 5-ft drop in the energy grade line over the section. The flow rate (cfs) is most nearly:

- A. 16
- B. 29
- C. 50
- D. 810

26. Assume that Bernoulli's equation applies (ignore head losses) to the pipe flow shown in the figure. Which of the following statements is most correct?



- A. Pressure head increases from 1 to 2.
- B. Pressure head decreases from 1 to 2.
- C. Pressure head remains unchanged from 1 to 2.
- D. Bernoulli's equation does not include pressure head.

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

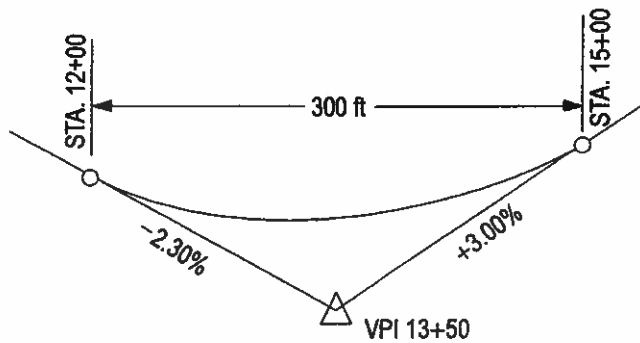
27. The following information is for a proposed horizontal curve in a new subdivision:

PI station	12+40.00
Degree of curve	10°
Deflection angle	12°30'

The station of the PT is most nearly:

- A. 12+79.80
- B. 12+80.10
- C. 13+02.00
- D. 13+64.75

28. For the sag vertical curve shown, the tangent slope at Station 14+00 is most nearly:



NOT TO SCALE

- A. +0.53%
- B. +1.23%
- C. +2.12%
- D. +2.77%

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

29. An interstate highway has the following traffic count data for a day in each month as shown below:

Jan.	63,500
Feb.	62,100
Mar.	64,400
Apr.	64,900
May	75,800
June	77,300
July	78,950
Aug.	77,200
Sept.	70,050
Oct.	69,000
Nov.	66,000
Dec.	<u>64,000</u>
Annual Total	833,200

To determine the seasonal average daily traffic volume for June through August, the seasonal factor to be multiplied by the average daily traffic volume is most nearly:

- A. 0.28
  - B. 0.89
  - C. 1.02
  - D. 1.12
30. The most essential criteria for proper soil classification using the Unified Soil Classification System or the AASHTO Soil Classification System are:
- A. water content and soil density
  - B. Atterberg limits and specific gravity
  - C. grain-size distribution and water content
  - D. grain-size distribution and Atterberg limits

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

31. The standard penetration test (SPT) is widely used as a simple and economic means of obtaining which of the following?
- A. A measurement of soil compressibility expressed in terms of a compression index
  - B. A direct measurement of the undrained shear strength
  - C. An indirect indication of the relative density of cohesionless soils
  - D. A direct measurement of the angle of internal friction
32. A department of transportation must remove and replace a 12-ft × 20-ft concrete slab on an interstate facility. To minimize disruption to traffic, the work must be completed during an 8-hour nighttime work shift. Nighttime temperatures average 50°F. If the minimum required compressive strength is 3,500 psi, the concrete mix most likely consists of:
- A. coarse aggregate, sand, Type II cement, chemical accelerator
  - B. sand, Type III cement, water, chemical accelerator
  - C. coarse aggregate, sand, Type V cement, water, chemical accelerator
  - D. coarse aggregate, sand, Type III cement, water, chemical accelerator



**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

33. Fatigue in steel can be the result of:
- A. a reduction in strength due to cyclical loads
  - B. deformation under impact loads
  - C. deflection due to overload
  - D. expansion due to corrosion

34. Sample concrete cylinders that are 6 inches in diameter and 12 inches high are tested to determine the compressive strength of the concrete  $f'_c$ . The test results are as follows:

Sample	Axial Compressive Failure Load (lb)
1	65,447
2	63,617
3	69,872

Based on the test results, the average 28-day compressive strength (psi) is most nearly:

- A. 615
- B. 2,250
- C. 2,340
- D. 2,470

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

35. During testing of a sample in the laboratory, the following soil data are collected:

Combined weight of compacted soil sample and mold = 9.11 lb

Water content of soil sample = 11.5%

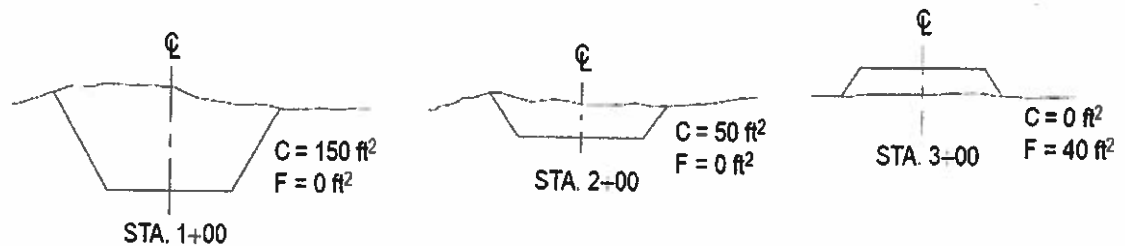
Weight of mold = 4.41 lb

Volume of mold = 0.03 ft<sup>3</sup>

The dry unit weight (pcf) of the soil sample is most nearly:

- A. 160
- B. 140
- C. 127
- D. 125

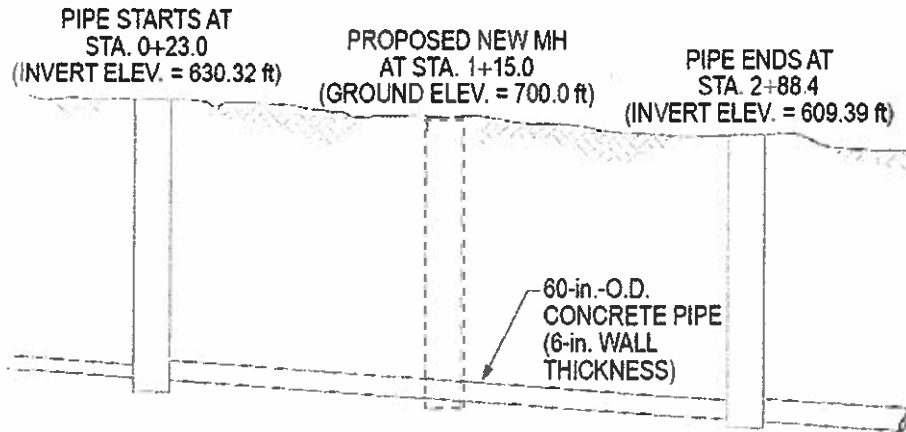
36. Refer to the figure. The net excess excavated material (yd<sup>3</sup>) from Station 1+00 to Station 3+00 is most nearly:



- A. 160
- B. 262
- C. 390
- D. 463

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

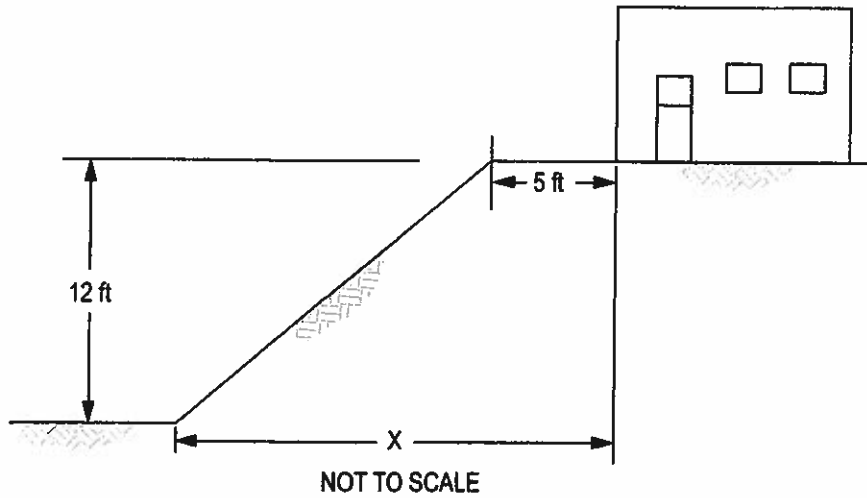
37. An existing pipe connects two maintenance holes (MH). A third MH is planned between the two. At the new MH, the elevation (ft) of the top of the pipe is most nearly:



- A. 623.06
  - B. 627.56
  - C. 628.06
  - D. 628.56
38. Which of the following is **not** a stormwater erosion classification?
- A. Sheet erosion
  - B. Rill erosion
  - C. Gully erosion
  - D. Rushing erosion

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

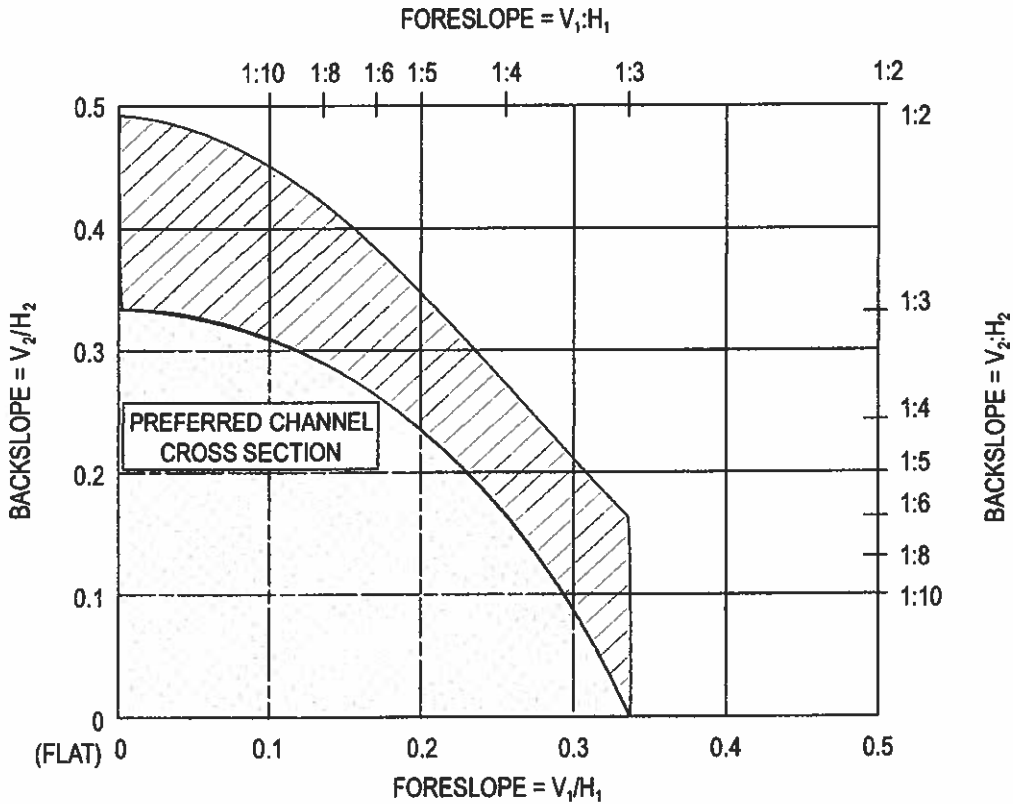
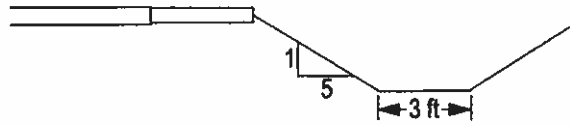
39. Based on the soil classification system found in the federal OSHA 29 CFR 1926, Subpart P, Excavations, the soil adjacent to an existing building has been classified as Type B. An undisturbed perimeter strip that is 5 ft wide is to be maintained along the face of the building. The excavation is to be 12 ft deep. To meet OSHA excavation requirements, the minimum horizontal distance  $X$  (ft) from the toe of the slope to the face of the structure is most nearly:



- A. 11
- B. 14
- C. 17
- D. 23

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

40. Based on the criteria provided, the steepest backslope (H:V) preferred in the ditch shown is most nearly:



- This area is applicable to all Vee ditches, rounded channels with a bottom width less than 2.4 m [8 ft], and trapezoidal channels with bottom widths less than 1.2 m [4 ft].
- This area is applicable to rounded channels with bottom width of 2.4 m [8 ft] or more and to trapezoidal channels with bottom widths equal to or greater than 1.2 m [4 ft].

Adapted from AASHTO *Roadside Design Guide*, 4th edition, 2011.

- A. 2:1
- B. 3:1
- C. 5:1
- D. 6:1

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

41. An industry is proposing to discharge its effluent into a nearby stream. Average design flow rates and the BOD<sub>5</sub> of its wastewater and the stream are as follows:

Parameter	Wastewater	Stream
Flow rate	10 MGD	100 cfs
BOD <sub>5</sub>	100 mg/L	2 mg/L

The in-stream BOD<sub>5</sub> standard for the area is 5 mg/L. The minimum effluent BOD<sub>5</sub> removal required to meet this standard is \_\_\_\_\_%.

Enter your response in the blank.

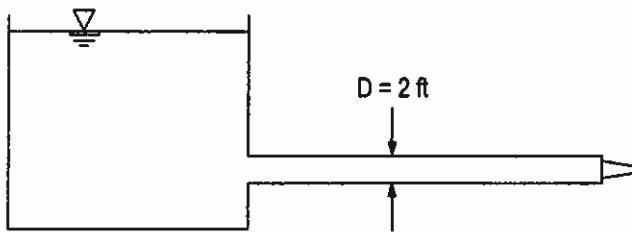
42. Three upflow clarifiers each have a diameter of 30 ft. If the total average flow for the combined clarifiers is 2 MGD, the overflow rate (gpd/ft<sup>2</sup>) for each clarifier is most nearly:
- A. 250
  - B. 950
  - C. 2,850
  - D. 8,500
43. A 60-ft-diameter aerobic digester with an 8-ft side wall depth treats 20,000 gpd of thickened secondary sludge that has a 2% solids concentration and is 75% volatile matter. The volatile solids loading rate [lb/(ft<sup>3</sup>-day)] is most nearly:
- A. 0.148
  - B. 0.111
  - C. 0.028
  - D. 0.013

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

44. A 90° V-notch weir has an upstream depth of 13 in. above the weir's crest. The flow (cfs) is most nearly:

- A. 1.44
- B. 1.75
- C. 3.10
- D. 1,510

45. Water flows from a reservoir through a pipe and then discharges into the atmosphere as shown. Neglect energy losses in the pipe entrance and exit. The water elevation is changed such that the 2-ft-diameter pipe is flowing at a velocity of 5 fps. A 4-in. nozzle is installed on the discharge end of the 2-ft-diameter pipe. The velocity (fps) of the discharge jet is most nearly:



- A. 1
- B. 5
- C. 180
- D. 720

46. Flow is delivered from a splitter box to an aeration basin through a 12-in. ductile iron pipe. For a flow rate of 3 MGD, the velocity head (ft) in the ductile iron pipe is most nearly:

- A. 0.03
- B. 0.54
- C. 5.91
- D. 59.1

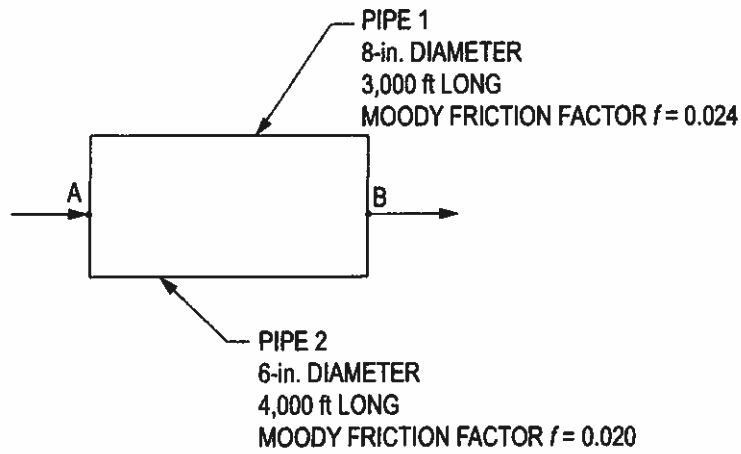
**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

47. Flow from a subdivision is collected in a detention basin. Assume that a short length of 3-ft-diameter reinforced concrete pipe with a square edge inlet (loss coefficient  $C_d = 0.5$ ) is used to drain the basin, the outlet of the pipe is unsubmerged, and the inlet head is 10 ft above the invert of the inlet end. The discharge (cfs) through the pipe is most nearly:
- A. 18
  - B. 85
  - C. 150
  - D. 330
48. A centrifugal pump has a power input of 20 hp, pumps water at the rate of 400 gpm, and produces a total dynamic pressure of 75 psi. The overall efficiency of the pump is most nearly:
- A. 1%
  - B. 28%
  - C. 47%
  - D. 88%



**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

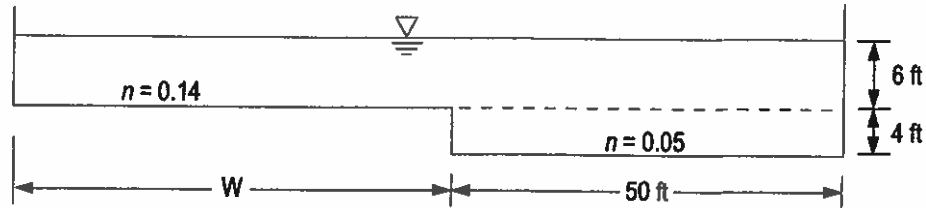
49. Given the pipe system shown in the figure, if the total flow through the system is 2 cfs, the flow rate (cfs) in the 8-in.-diameter pipeline is most nearly:



- A. 1.45
- B. 1.37
- C. 1.23
- D. 1.0

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

50. The channel shown has a longitudinal slope of 0.001 ft/ft. For a design flood of 3,000 cfs, the **minimum** width  $W$  (ft) of the overbank section necessary to keep the water depth in the channel no greater than 10 ft under uniform velocity is most nearly:



- A. 176
- B. 80
- C. 65
- D. 31
51. A sanitary sewer line must be designed with a slope of 0.20%. The design flow for the line has been determined to be 3.0 MGD including consideration for growth and wet weather.

Assume the following:

- A Manning's  $n$  factor of 0.012 for gravity flow in the sewer line.  
The pipe does not surcharge.

The minimum diameter (in.) of a sanitary sewer line required to handle the design flow is most nearly:

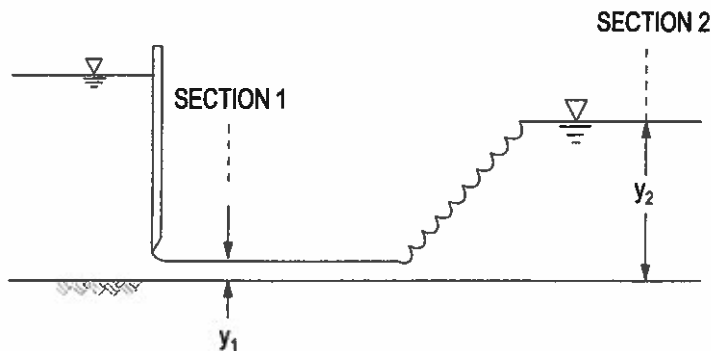
- A. 12
- B. 15
- C. 18
- D. 24

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52. An existing broad-crested spillway has a design discharge of 1,815 cfs, a crest length of 40 ft, and a design head of 6 ft. It is desired to increase the discharge capacity to 2,500 cfs without changing the design head. If the approach velocity is negligible, the increase in length (ft) of the spillway is most nearly:

- A. 16
- B. 55
- C. 95
- D. 135

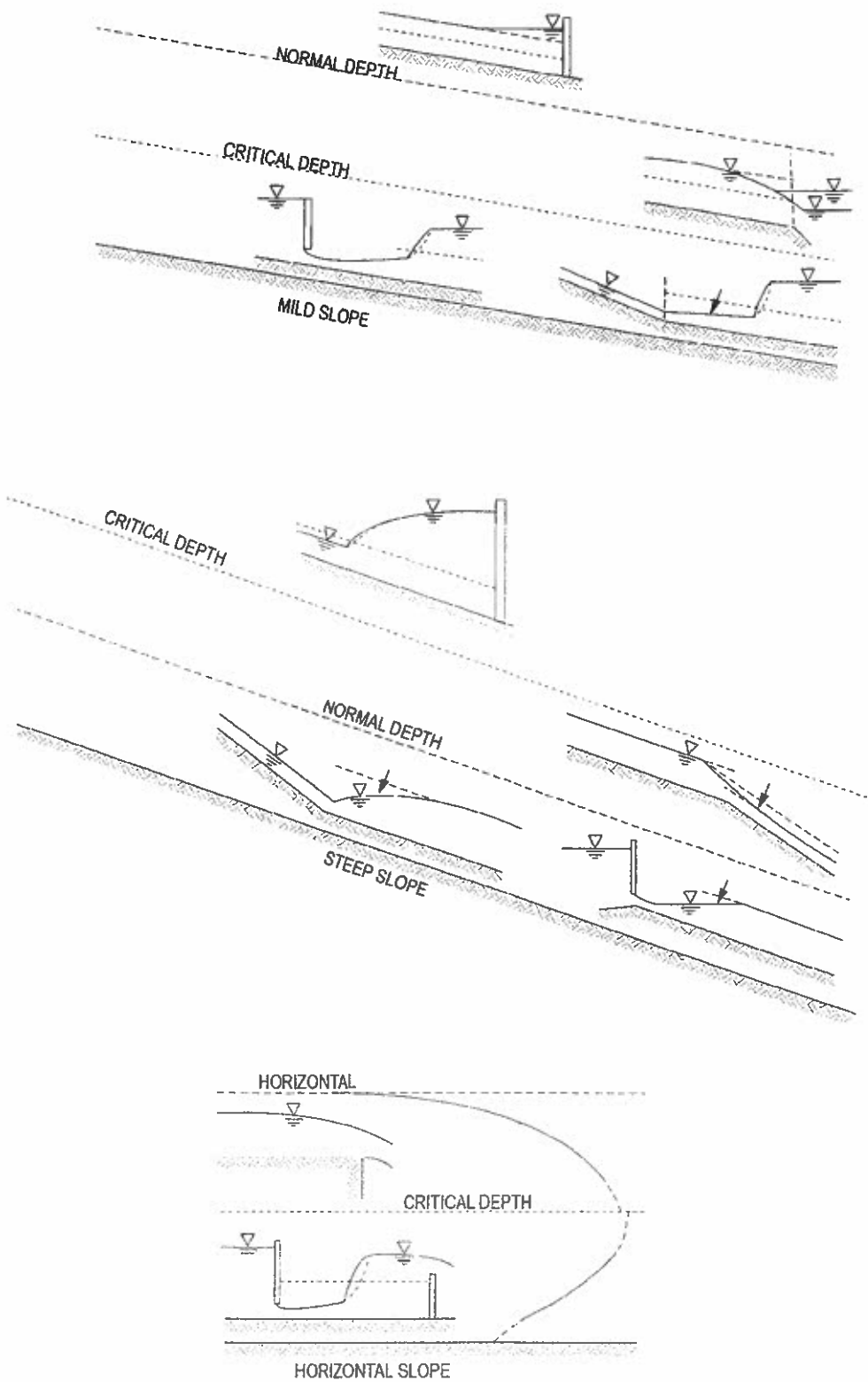
53. The figure shows a sluice gate in a 35-ft-wide rectangular channel. At Section 1,  $y_1$  is 3.8 ft and the velocity is 50 ft/sec. The Froude number at Section 2 is most nearly:



- A. 0.012
- B. 0.11
- C. 0.31
- D. 0.61

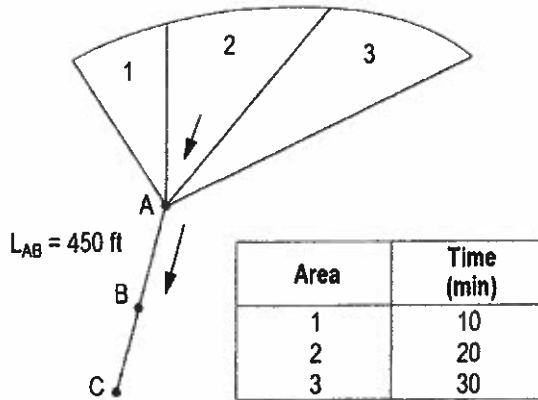
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54. Select all flow profiles representing supercritical flow.



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55. Three contributing areas of a watershed have the times of concentration for runoff flows contributing to an outlet at Point A as shown in the table portion of the figure. Assume the distance from Point A to the next inflow point (Point B) is 450 ft and the velocity in Pipe AB is 3 fps. The time of concentration (min) to be used for the design of Pipe BC is most nearly:



- A. 2.5
- B. 10.0
- C. 32.5
- D. 60.0

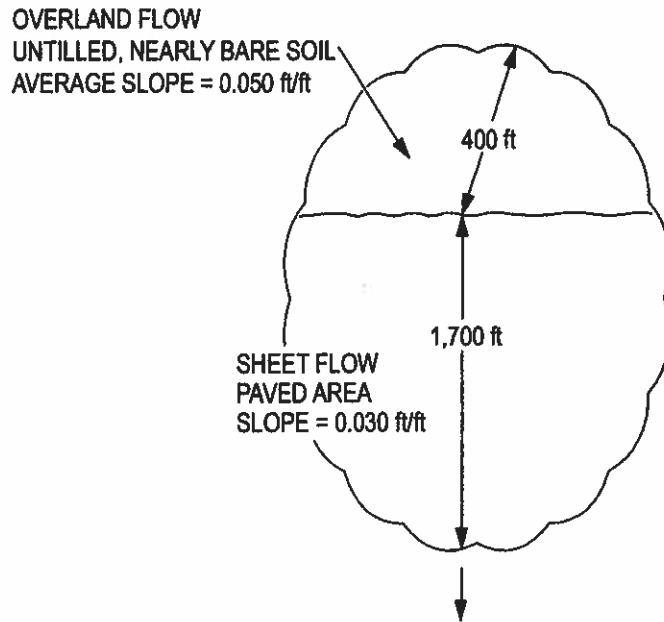
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56. A unit runoff hydrograph for a 200-acre watershed has a triangular shape and a duration of 4 hours. The peak flow rate (cfs/in. of precipitation) for the runoff (ignoring any infiltration through the soil) is most nearly:

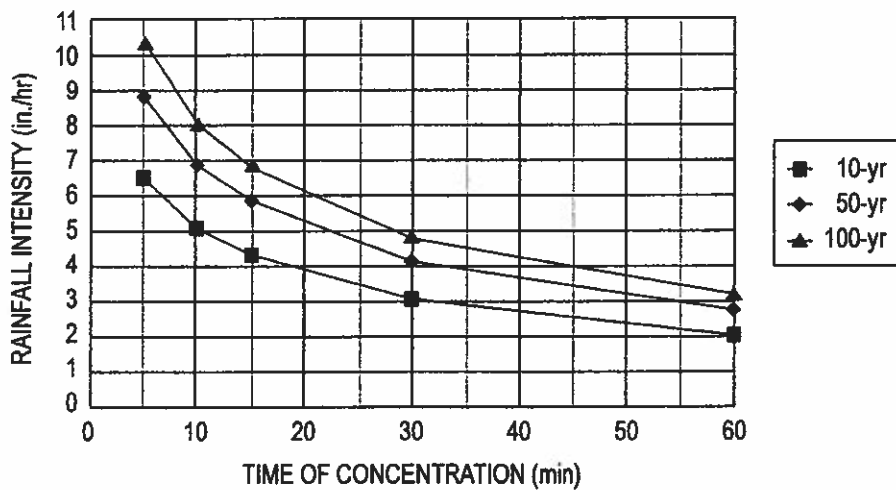
- A. 50
- B. 100
- C. 200
- D. 400

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57. A drainage basin has a total watercourse length of 2,100 ft to the hydraulically most remote point. The water flows as shown in **Figure 1**. **Figure 2** shows intensity-duration-frequency curves for the basin, and **Figure 3** shows flow velocities for overland and shallow concentrated flows. The rainfall intensity (in./hr) for a 50-year storm is most nearly:



**FIGURE 1**

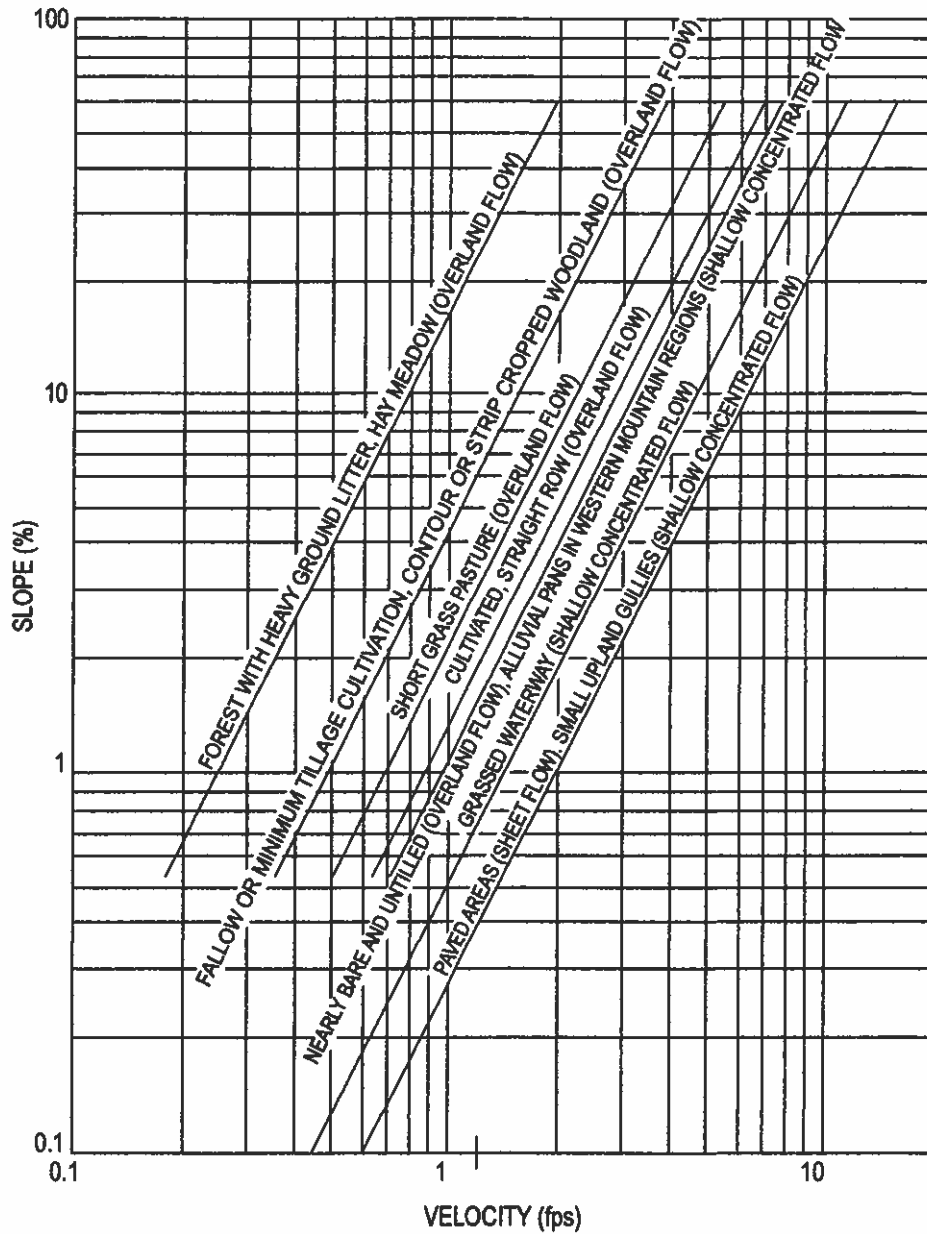


**FIGURE 2**

- A. 4.6
- B. 5.8
- C. 6.5
- D. 7.6

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57. (Continued)



Note: For watercourses with slopes less than 0.5 percent, use the overland flow velocity given for 0.5 percent, except for shallow concentrated flow where a flatter slope may be considered.

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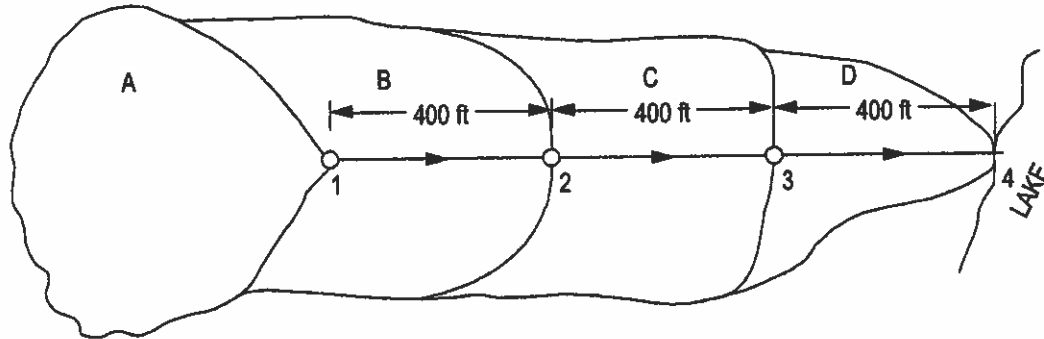
FIGURE 3



**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

58. A stormwater collection system drains the areas shown into a lake. Using the rational method for determining peak flow, the time of concentration  $T_c$  (min) that should be used to determine the peak discharge at the point where the pipe discharges into the lake is most nearly:

Drainage Zone	A	B	C	D
Area, acres	10	12	11	9
$T_c$ for overland flow in this zone, min	10	12	12	7
Velocity in pipe, fps		3.2	3.6	3.9



- A. 13
- B. 16
- C. 21
- D. 43

59. A basic assumption of the rational method for determining peak runoff from a watershed is that peak runoff for a given rainfall intensity:

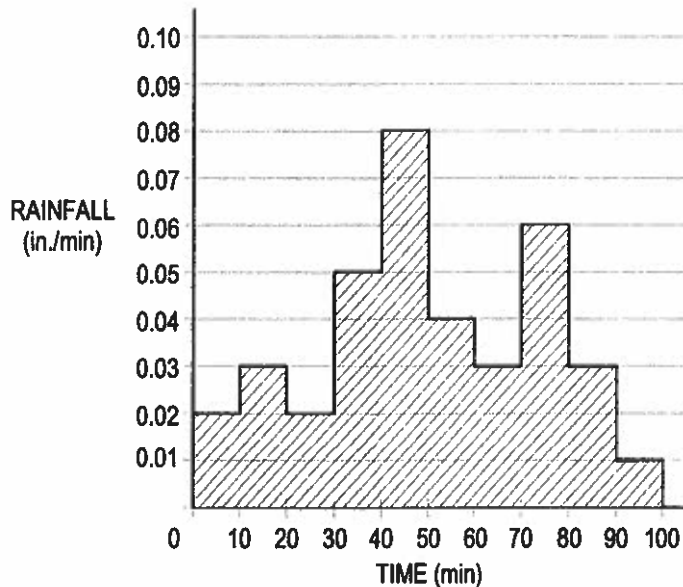
- A. occurs if rainfall duration is equal to or greater than the time of concentration
- B. is independent of the rainfall intensity
- C. occurs only if peak discharge per unit area increases as the drainage area increases
- D. occurs if rainfall duration is less than the time of concentration

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

60. A lake has a surface area of  $10,000,000 \text{ ft}^2$  and an impervious bottom and sides. For the month of June, the average inflow was 5.0 cfs and the average outflow was 4.5 cfs. The precipitation recorded for the month was 4 in. and the storage volume decreased by  $83,000 \text{ ft}^3$ . The estimated evaporation (in.) is most nearly:

- A. 2.54
- B. 4.15
- C. 5.65
- D. 56.5

61. The figure shows a graph of rainfall over time falling on a 100-acre site. Assume 0.2 in. of rainfall is infiltrated each 10 min for the first 30 min. Further assume the surface storage on the site is  $440,000 \text{ ft}^3$ . If the rest of the water flows to a 1-acre retention pond with vertical sides and is retained, then the water depth (ft) in the pond is most nearly:



- A. 16
- B. 21
- C. 26
- D. 31

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

62. A horizontal confined aquifer is made up of three layers with the following properties:

Layer	Thickness (ft)	Hydraulic Conductivity (ft/day)
Upper	30	30
Middle	60	3
Lower	210	0.3

The aquifer transmissivity ( $\text{ft}^2/\text{day}$ ) is most nearly:

- A. 900
  - B. 1,000
  - C. 1,150
  - D. 10,000
63. An unconfined aquifer is 30 ft in depth. The slope of its groundwater table in the direction of flow is 5 ft in 1,000 ft. The hydraulic conductivity of the aquifer soil is 0.8 ft/min. The flow rate of water (cfs/ft of width perpendicular to flow) through the aquifer is most nearly:
- A. 2.0
  - B.  $1.3 \times 10^{-1}$
  - C.  $2.0 \times 10^{-3}$
  - D.  $6.7 \times 10^{-5}$

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

64. A 16-in.-diameter well is pumping at the rate of 1,900 gpm. This well fully penetrates an unconfined aquifer underlain by an impervious stratum 140 ft below the ground surface. The following table shows steady-state water levels in the pumping well and in an observation well located 1,050 ft from the pumping well. The ground surface is level.

Well	Water Level Below Ground Surface After Pumping (ft)
Pumping well	49
Observation well	27

The average permeability (ft/day) of the porous medium in this aquifer is most nearly:

- A. 1
  - B. 80
  - C. 200
  - D. 280
65. A community with a population of 25,000 is planning to expand its wastewater treatment plant. Using the table below for daily flows and assuming a 15% population increase over 5 years and a peak flow factor of 2.5 of the daily flow, the peak flow (MGD) at the end of the 5 years is most nearly:

Flow Type	Daily Flow Rate [gal/(capita-day)]
Domestic	70
Commercial	10

- A. 2.0
- B. 2.3
- C. 5.0
- D. 5.7

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

66. The primary clarifier of a trickling filter plant receives 1,000 lb of solids daily. The clarifier has a solids capture rate of 90% and produces an underflow sludge concentration of 9%. The volume of primary sludge ( $\text{ft}^3/\text{day}$ ) is most nearly:
- A. 2
  - B. 80
  - C. 160
  - D. 210
67. A 10-MGD activated sludge plant is being designed to treat domestic wastewater. The following operational design parameters are chosen: the mixed liquor volatile suspended solids concentration in the aeration basin is 2,200 mg/L; the influent  $\text{BOD}_5$  concentration is 200 mg/L of which 35% is removed by primary clarification; the food-to-microorganism ratio in the aeration basin is  $0.2 \text{ day}^{-1}$ . The total aeration tank volume required ( $\text{ft}^3$ ) is most nearly:
- A. 213,000
  - B. 316,000
  - C. 395,000
  - D. 608,000
68. Ignoring cell synthesis, how many moles of  $\text{O}_2$  per mole of  $\text{NH}_4^+$  oxidized are required in the nitrification of  $\text{NH}_4^+$  to  $\text{NO}_3^-$ ?
- A. 1
  - B. 2
  - C. 3
  - D. 4

## PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM

69. Primary sewage sludge from a 5-MGD wastewater treatment plant is to be treated by anaerobic digestion. The following data apply:

$\theta_c$ in digester	14 days at 30°C
Moisture content of primary sludge	95%
Specific gravity of sludge	1.05
Dry solids removed in primary tank	6,500 lb/day

The required volume (ft<sup>3</sup>) of the anaerobic digester is most nearly:

- A. 1,830
  - B. 5,124
  - C. 26,900
  - D. 27,800
70. A consulting engineer is performing a diagnostic evaluation of a 0.5-MGD wastewater treatment plant. The engineer is required to evaluate the existing chlorination system, which consists of two 150-lb cylinders. Using a chlorine dosage of 8 mg/L, the number of days of disinfection the system will provide is most nearly:
- A. 4.5
  - B. 9.0
  - C. 17.0
  - D. 34.0

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

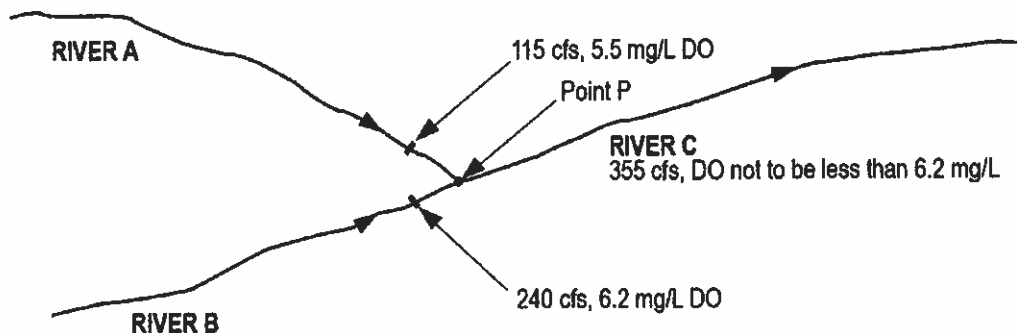
71. Selected water quality parameters for a river and a tributary are as follows:

Parameter	River	Tributary
Flow rate (cfs)	50	20
Total phosphorus (mg/L)	0.02	0.5
Chlorophyll (mg/L)	0.05	0.1

Recognizing that algae growth in this system is limited by phosphorus concentrations less than 0.015 mg/L, the longitudinal profile of the algae concentration in the main river downstream of the confluence point will probably:

- A. stay the same
- B. decrease continuously
- C. decrease first and then increase
- D. increase first and then decrease

72. River A converges with River B and forms River C at Point P as shown in the figure. It is proposed to install in-stream aeration in River A to increase the dissolved oxygen (DO) to 6.2 mg/L just upstream of Point P. If the aerator is capable of supplying an average of 0.28 lb DO/day per linear ft, the number of linear feet of aerators required to improve the water quality of River A is most nearly:



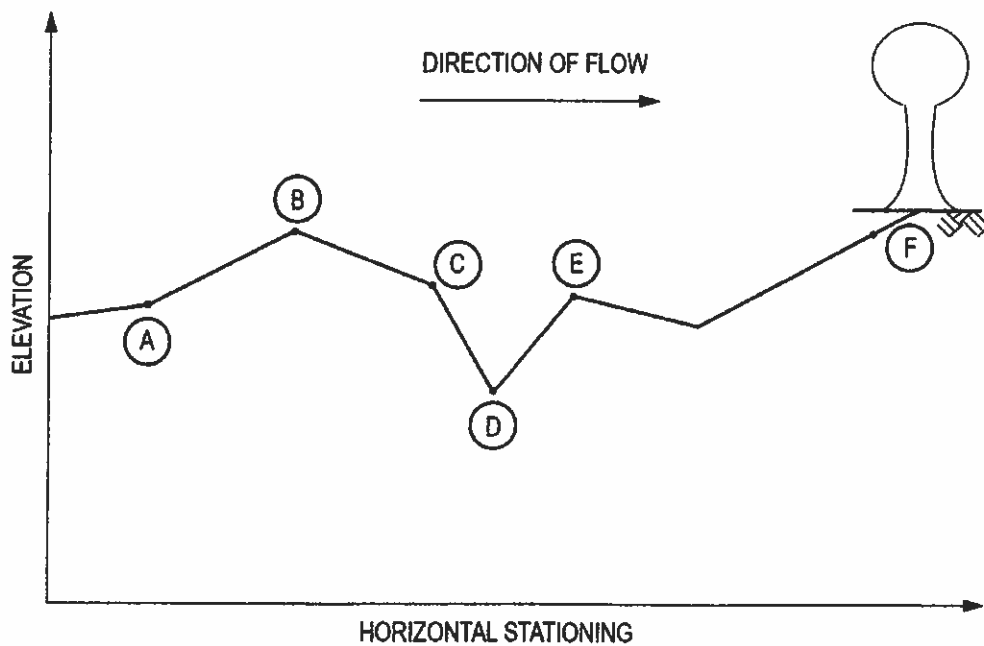
- A. 210
- B. 410
- C. 1,550
- D. 13,700

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73. A person who weighs 78 kg drinks 2.3 L/day of water contaminated with 0.5 mg/L of heptachlor for 6 years. The slope factor for heptachlor is 4.5 kg-day/mg. The 75-yr lifetime cancer risk is most nearly:

- A.  $1 \times 10^{-5}$
- B.  $1 \times 10^{-3}$
- C.  $5 \times 10^{-3}$
- D.  $7 \times 10^{-2}$

74. The figure shows the profile of a water main. Identify the points where air release valves should be installed for proper operation of this water main.



Select the two that apply.

- A. Point A
- B. Point B
- C. Point C
- D. Point D
- E. Point E
- F. Point F



**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

75. A city had a 2000 census population of 85,000 people and a 2010 census population of 92,000 people. If the water usage remains constant at 160 gal/(capita-day) (gpcd), and assuming a geometric growth rate, the additional daily demand (gal/day) in 2017 above that in 2010 due to population growth is most nearly:

- A. 840,000
- B. 1,200,000
- C. 15,500,000
- D. 16,000,000

76. You are designing an elevated (potable) water tank. Match the system requirements/data to the tank design parameters they influence.

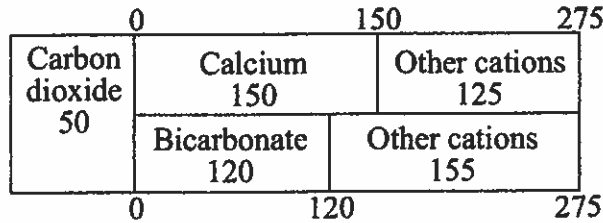
Tank Design Parameters	System Requirements/Data
Maximum elevation	Fire-flow duration
<input type="text"/>	Chlorine residual
<input type="text"/>	Flight path
Minimum elevation	Service pressure
<input type="text"/>	Pump total discharge head (TDH)
Volume	Floodplain elevation
<input type="text"/>	Surface overflow rate
<input type="text"/>	

**PE CIVIL: WATER RESOURCES AND ENVIRONMENTAL PRACTICE EXAM**

77. With a design retention time of 1 min, dynamic viscosity of  $2.735 \times 10^{-5}$  lb-sec/ft<sup>2</sup>, and a velocity gradient value of  $700 \text{ sec}^{-1}$ , the power (ft-lb/sec) that must be imparted to 1 MGD of water passing through a rapid mix unit is most nearly:
- A. 700
  - B. 1,240
  - C. 9,300
  - D. 74,400
78. A 16-ft  $\times$  40-ft dual media drinking water filter is to be cleaned using an air wash followed by a water wash. The air wash is at a rate of 5 scfm/ft<sup>2</sup>. The recommended airflow rate (scfm) for the air wash is most nearly:
- A. 5
  - B. 1,280
  - C. 3,200
  - D. 8,000

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79. The constituents of a water supply are shown in the bar chart. There is no magnesium. It is desired to remove the carbonate hardness due to calcium. No noncarbonate hardness will be removed. Excess lime beyond the stoichiometric amount will be added at a dose of 20 mg/L as CaCO<sub>3</sub>. The total amount of lime (mg/L as CaCO<sub>3</sub>) that must be added is most nearly:



Length of bars not to scale.  
All concentrations are mg/L as CaCO<sub>3</sub>.

- A. 140
  - B. 150
  - C. 190
  - D. 220
80. A utility company can purchase a packaged wastewater plant with a capital cost of \$10,000,000 and a maintenance cost of \$200,000/year. Another option is to lease the plant with a \$1,000,000 down payment and \$600,000 semiannual payments (including maintenance). Assume the plant has a salvage value of zero. Which of the following statements is most accurate using present worth analysis, 6% interest, and a 20-year useful life/lease period?
- A. Buying is better by \$2.6 million.
  - B. Buying is better by \$4.9 million.
  - C. Leasing is better by \$4.4 million.
  - D. Buying and leasing costs are about the same.