

# ***CWEA COLLECTION SYSTEM OPERATOR CERTIFICATION***

## ***MATH FOR GRADES 1 AND 2***

1

### **FINDING THE AREA OF A CIRCLE**

- When finding the area of a circle you need to take the diameter of the circle and times it by it self, and then multiply by .785
- .785 is a constant when dealing with diameter of a circular pipe.

2

**TO FIND THE AREA YOU MUST  
CHANGE INCEHS INTO FEET  
SEE EXAMPLE BELOW**

- Take the inches that you need to change and divide them by 12
- There is 12 inches in a foot
- Example:  $6''/12'' = .5'$
- Example:  $8''/12'' = .666666667$  if this happens, round up to the next number after three spots.
- example.  $.666666667$  would be  $.667$

3

**Example conversion**

- Example: What is the diameter of a 6" pipe?  $6''/12'' = 5'$ , so you take  $.5 \times .5 \times .785 = 0.19625$  or round up to  $0.196$
- Diameter is from one side of the circle to the other side.

+



.785 is for the missing corners

4

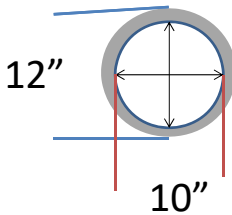
## QUESTION # 6

The interior of 300 feet of 12- inch pipe is uniformly coated with one inch of grease. How many gallons will this pipe hold when filled with water?

5

## QUESTION # 6

- 12" pipe uniformly coated with 1" of grease. What is the "true" diameter of the opening?



6

## QUESTION # 6

- $10''/12'' = .833'$
- $.833' \times .833' \times .785 =$   
 $.545\text{sq.}' \times 300' = 163.41\text{cu.}'$
- $163.41\text{cu.}' \times 7.48\text{gals/cu.}' =$   
 $1,222.3\text{gals.}$

7

## ANSWER TO QUESTION #6

**1,222 GALLONS**

8

## QUESTION #12

A flow of 650 gpm would be how many mgd?

9

## CONVERTING TIME

- TO CHANGE DAYS INTO HOURS: TAKE THE DAYS THAT YOU HAVE AND MULTIPLY BY 24/HRS. IN A DAY
- TO CHANGES HRS. TO MINUTES: TAKE THE HRS. THAT YOU HAVE AND MULTIPLY BY 60/MIN. IN A HOUR.
- TO CHANGES MINUTES INTO SECONDS: TAKE THE MIN. THAT YOU HAVE AND MULTIPLY BY 60/SEC. IN A MIN.

10

## QUESTION # 12

- Take 650 gpm X 1440 min./day = ?
- (~~650gpm~~ X ~~1440min~~pd =)
- Min. cancel min. leaving you with 650 gals. X 1440 day = 936,000 gpd.
- But they want this in million gallons/day.
- Take 936,000 gpd and divide (/) by 1,000,000 = .936mgd

11

## ANSWER TO QUESTION # 12

0.936mgd

12

**QUESTION # 14**

If it takes 7 minutes and 30 seconds for dye to travel a distance of 860 feet through an eight inch sewer, what is the velocity in fps?

13

**QUESTION # 14**

- Need to change minutes into seconds
- Take  $7\text{min} \times 60\text{spm} = 420\text{sec} + 30\text{sec} = 450\text{sec}$
- Take the  $860' / 450\text{sec} = 1.91\text{fps}$

14

## ANSWER TO QUESTION # 14

1.91fps

15

## Question #16

You receive a dispatch at 4:30 P.M. informing you that raw sewage is spewing out of a manhole onto the ground and into a small stream adjacent to a sparsely populated neighborhood. The caller reporting the problem indicated that it had been spilling sewage since 2P.M. and that she noticed it while driving by on the 405 freeway stuck in stop and go traffic. She indicated that she was not able to call right away and report the spill because of restrictions on using cell phone when driving a motor vehicle. You immediately dispatch a hydro-vac crew to the site to assist you in taking care of the problem. Upon arrival at the manhole at 5:15P.M., you notice right away the sewage is spilling out from around an unsecured 24-inch bolt down manhole cover. You field measure the height of the sewage from the top of the frame. Based on current engineered SSO volume estimation, a sewage spout 5 inches above a manhole rim with culver still in place tabulates out to 166 gallons per minute. You also notice that the SSO is flowing from between the manhole and the creek. As the creek was flowing rather high that afternoon after an earlier rainstorm, none of the spill would be recoverable. Your crews had setup their equipment and were able to clear the problem causing the mainline stoppage 22 minutes after your arrival. Based on the information supplied, how many reportable unrecoverable gallons of raw sewage had reached the creek?

16



## **QUESTION # 16**

- Estimate spill time
- Convert into minutes
- Estimate amount of the spill in gallons per minute
- Multiply the spill time by the gallons per minute
- Equals “answer”

17

## **QUESTION # 16**

- Caller indicated that she notice the spill at 2P.M.  
(You receive a dispatch at 4:30 P.M. The caller reporting the problem indicated that it had been spilling sewage since 2P.M.)
- You arrive at 5:15P.M.
- Crew clear the problem in 22 minutes.
- What is your total time

18

## QUESTION # 16

- Subtract ~~2P.M.~~ from ~~5:15P.M.~~ = 3hrs 15min
- 
- Turn 3 hrs into minutes by multiplying by 60mph ( ~~3hrs X 60 mph~~ = 180min )
- Add the 15 min onto the 180 min ( 15min + 180 min = 195 min )

19

## QUESTION # 16

Crew time of 22min add  
to 195min you have =  
22min + 195min =  
217min

20

**QUESTION # 16**

166 gallons per minute.

21

**QUESTION # 16**

166 gpm X 217 min =

22

**QUESTION # 16**

**ANSWER**

**36,022 gallons**

23

**LETS  
REVIEW**

24

## HOW TO CHANGE INCHES INTO FEET

- Take the inches that you need to change and divide them by 12
- There is 12 inches in a foot
- Example:  $6''/12'' = .5'$
- Example:  $8''/12'' = .666666667$  if this happens, round up to the next number after three spots.
- example.  $.666666667$  would be  $.667$

25

## FINDING THE AREA OF A CIRCLE

- When finding the area of a circle you need to take the diameter of the circle and times it by it self, and then multiply by .785
- Example: What is the diameter of a 6'' pipe?  
 $6'' = .5'$ , so you take  $.5 \times .5 \times .785 = 0.19625$  or round up to  $0.196$
- Diameter is from one side of the circle to the other side.



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## CONVERTING TIME

- TO CHANGE DAYS INTO HOURS: TAKE THE DAYS THAT YOU HAVE AND MULTIPLY BY 24/HRS. IN A DAY
- TO CHANGES HRS. TO MINUTES: TAKE THE HRS. THAT YOU HAVE AND MULTIPLY BY 60/MIN. IN A HOUR.
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## EXAMPLE

- $3\text{days} \times 24\text{hrs/day} = ?$  Days cancel days ( $3\cancel{\text{days}} \times 24\text{hrd}$ ) leaving you with  $3 \times 24\text{hrs} = 72\text{hrs}$ .
- $24\text{hrs/day} \times 60\text{min/hr} = ?$  Hrs. cancel hrs. ( $24\cancel{\text{hrd}} \times 60\text{mhr}$ ) leaving you with  $24/\text{day} \times 60\text{min} = 1,440\text{mpd}$  (minute per day)
- $1440\text{mpd} \times 60\text{spm} = ?$  Min. cancel min. ( $1440\cancel{\text{mpd}} \times 60\text{spm}$ ) leaving you with  $1440/\text{day} \times 60\text{sec.} = 86,400\text{spd}$ . (second per day)

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**QUESTION # 42**

If a 6" force main has a metered flow of 200,000gpd, what is the velocity?

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**FLOW  
FORMULA**

Q = Flow (Quantity) (gpd, gpm, gps)

V = Velocity (fps)

A = Area (sq. ft.)

$$Q = A \times V$$

$$V = Q/A$$

$$A = Q/V$$

30

## QUESTION # 42

- $6\text{in}/12\text{in} = 0.5\text{ft}$
- $0.5 \times 0.5 \times 0.785 = 0.196\text{sq.ft. (area)}$
- $200,000\text{gpd}/1440\text{mpd} = 138.889\text{gpm}$  (needs to be in seconds)
- $138.889\text{gpm}/60\text{spm} = 2.315\text{gps}$

31

## QUESTION # 42

- $6\text{in}/12\text{in} = 0.5\text{ft.}$
- $0.5 \times 0.5 \times 0.785 = 0.196\text{sq.ft. (area)}$
- $200,000\text{gpd}/1440\text{mpd} = 138.889\text{gpm}$  (needs to be in seconds)
- $138.889\text{gpm}/60\text{spm} = 2.315\text{gps}$
- $2.315\text{gps}/7.48\text{gcf} = 0.309\text{cfs}$
- $0.309\text{cfs}/0.196\text{sq.ft.} = 1.58\text{fps}$

32



QUESTION # 42  
ANSWER

**1.6FPS**

(actual answer is 1.58)

33

QUESTION # 43

Wastewater is pumped through an 8" force main @ the rate of 425gpm. What is the velocity?

34

## QUESTION # 43

$$\cancel{8\text{in}}/\cancel{12\text{in}} = 0.667'$$

$$0.667' \times 0.667' \times 7.85 = 0.349\text{sqf}$$

$$\cancel{425\text{gpm}} / \cancel{60\text{spm}} = 7.08\text{gps}$$

$$7.08\cancel{\text{gps}} / 7.48\cancel{\text{gcuft}} = 0.946\text{cfs}$$

$$0.946\cancel{\text{cfs}}/0.349\cancel{\text{sqf}} = 2.71\text{fps}$$

35

## QUESTION # 43

### ANSWER

# 2.7FPS

(actual answer 2.712 round down)

36

### QUESTION # 44

An 8" pipe serves 1,837 homes with 2.6 people per home using 100 gallons of water each day.

What is the velocity in fps?

37

### QUESTION # 44

$$8 \text{ inches} / \frac{\text{inches}}{\text{foot}} = 0.667 \text{ feet}$$

$$0.667' \times 0.667' \times 0.785 = 0.349 \text{ sqft}$$

38

## QUESTION # 44

- $1,837 \text{ homes} \times 100 \frac{\text{gallons/day}}{\text{home}} = 183,700 \frac{\text{gallons}}{\text{day}}$
- $183,700 \text{gpd} / 1440 \text{mpd} = 127.569 \text{gpm}$
- $127.569 \text{gpm} / 60 \text{spm} = 2.126 \text{gps}$

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## QUESTION # 44

- Need to change the 2.126gps into feet per second
- $2.126 \frac{\text{gallons}}{\text{second}} / 7.48 \frac{\text{gallons}}{\text{cu.foot}} = 0.284 \frac{\text{cubic feet}}{\text{second}}$
- $0.284 \frac{\text{cubic feet}}{\text{second}} / 0.349 \text{cft} = 0.813 \frac{\text{feet}}{\text{second}}$

40

**QUESTION # 44**

**ANSWER**

**0.81fps**

41

***CWEA COLLECTION SYSTEM  
OPERATOR CERTIFICATION***

***MATH  
FOR  
GRADES 3 AND 4***

42

**QUESTION # 1**

A pump station has three constant speed pumps with a field measure horsepower of the pumps of 73 (pump #1), 78 (pump #2) and 71 (pump #3). By changing to new, more efficient pumps, the horsepower can be reduced to 65 horsepower per pump and maintain the same flow rate.

Total cost of conversion:	\$64,000.00
Power costs	\$0.63 cent/KwH
pump station Average flow	10.5mgd
Hour Meter Reading	
	Beginning of Year      End of Year
Pump 1	110,356                  115,293
Pump 2	24,224                    25,031
Pump 3	38,331                    39,622

Given the information above, determine the annual saving in dollars, if new pumps are installed:

43

**QUESTION # 1**

Determined the different in horsepower between the old pumps and the new pumps

	<u>old</u>	<u>new</u>	<u>difference</u>
<b>Pump # 1</b>	73hp	- 65hp	= 8hp
<b>Pump # 2</b>	78hp	- 65hp	= 13hp
<b>Pump # 3</b>	71hp	- 65hp	= 6hp

44

## QUESTION # 1

Change the horsepower of the pumps into kilowatts (one horsepower = .746kw)

$$\text{Pump \#1} \quad 8\cancel{\text{hp}} \times \frac{.746\text{kw}}{1\cancel{\text{hp}}} = 5.968\text{kw}$$

$$\text{Pump \# 2} \quad 13\cancel{\text{hp}} \times \frac{.746\text{kw}}{1\cancel{\text{hp}}} = 9.698\text{kw}$$

$$\text{Pump \# 3} \quad 6\cancel{\text{hp}} \times \frac{.746\text{kw}}{1\cancel{\text{hp}}} = 4.476\text{kw}$$

45

## QUESTION # 1

Change the kilowatts of the pumps to cost per hour per pump (\$0.63cent/Kw Hours)

$$\text{Pump \# 1} \quad 5.968\cancel{\text{kw}} \times \frac{\$0.63\cancel{\text{kw}}}{1\cancel{\text{hour}}} = \$3.76/\text{hour}$$

$$\text{Pump \# 2} \quad 9.698\cancel{\text{kw}} \times \frac{\$0.63\cancel{\text{kw}}}{1\cancel{\text{hour}}} = \$6.11/\text{hour}$$

$$\text{Pump \# 3} \quad 4.476\cancel{\text{kw}} \times \frac{\$0.63\cancel{\text{kw}}}{1\cancel{\text{hour}}} = \$2.82/\text{hour}$$

46

## QUESTION # 1

Determine the annual hours that the pumps have run, by taking the end of year and subtracting from the beginning of year from your Hour Meter Reading

	Hour Meter Reading	
	Beginning of Year	End of Year
Pump 1	110,356	115,293
Pump 2	24,224	25,031
Pump 3	38,331	39,622

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## QUESTION # 1

	<i>End of year</i>	<i>Beginning of year</i>	<i>Total Annual Hours</i>
<b>Pump # 1</b>	<b>115,293</b>	<b>110,356</b>	<b>= 4,937</b>
<b>Pump # 2</b>	<b>25,000</b>	<b>24,224</b>	<b>= 807</b>
<b>Pump # 3</b>	<b>39,622</b>	<b>38,331</b>	<b>= 1,291</b>

48



## QUESTION # 1

Take the hourly cost of the pumps and multiply by the annual hours per pump

$$\text{Pump \# 1 } \$3.76/\text{hr} \times \frac{4,937\text{hrs}}{1\text{year}} = \$18,563.12/\text{year}$$

$$\text{Pump \# 2 } \$6.11/\text{hr} \times \frac{807\text{hrs}}{1\text{year}} = \$4,930.77/\text{year}$$

$$\text{Pump \# 3 } \$2.82/\text{hr} \times \frac{1,291\text{hrs}}{1\text{year}} = \$3,640.62/\text{year}$$

49

## QUESTION # 1

Take the annual cost per pump, and add them together, then you'll have your total annual saving in dollars

**Pump # 1**      \$18,563.12/year

**Pump # 2**      \$4,930.77/year

**Pump # 3**      \$3,640.62/year

**Annual Total**      **\$27,134.51**

50

**QUESTION # 1****ANSWER**

**\$27,134.51 / YEAR**

51

**QUESTION # 1**

- Determine the different in horsepower between the old pumps and the new pumps
- Change the horsepower of the pumps into kilowatts (one horsepower = .746kw)
- Change the kilowatts of the pumps to cost per hour per pump (\$0.63cent/KwHour)
- Determine the annual hours that the pumps have run, by taking the end of year and subtracting from the beginning of year from your Hour Meter Reading
- Take the hourly cost of the pumps and multiply by the annual hours per pump
- Take the total hours of your annual hours per pump, and add them together, then you'll have your annual saving in dollars.

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## QUESTION # 68

You are the superintendent of an 18 worker collection system maintenance operation. Last year 4 workers cleaned 150 miles of pipe using power rodding (40%) and high-velocity cleaners (60%). The power rodder cost \$14,800 per year to own and operate (excluding labor) and the high-velocity cleaner cost \$27,500 per year. The remaining workers replace 40,000 feet of 6 inch and 8 inch pipe at 680 work sites. The construction equipment cost \$199,870 per year to own and operate. There are 220 working days per year and each worker costs \$250 per day for salary and benefits.

What are the unit costs, in dollars per foot, for cleaning?

53

## Determine what needs to be done

*Need to figure out the cost of cleaning the line*

The cleaning was done by only 4 of the workers  
What was the cost of the workers cleaning the line

$$\frac{\$250.00}{\text{worker}} \times 4 \text{ workers} = \$1,000.00$$

$$\frac{220 \text{ working days}}{\text{year}} \times \frac{\$1,000.00}{\text{day}} = \frac{\$220,000.00}{\text{year}}$$

What tools were used for cleaning, and what was there cost

<u>tools used</u>	<u>cost per year</u>
power rodder	\$14,800.00
high-velocity cleaner	\$27,500.00
	\$42,300.00

54

## Determine what needs to be done

### *Footage of line clean that year*

150 miles of lines were cleaned

Change miles into feet (5,280ft/mile)

$$150 \text{ miles} \times \frac{5,280 \text{ ft}}{\text{mile}} = 792,000 \text{ ft}$$

55

## TAKE THE TOTAL COST OF THE WORKERS AND EQUIPMENT, ADD THEM TOGETHER

Total cost of the workers      \$220,000.00/year

Total cost of tools used      \$42,300.00/year

Total cost      \$262,300.00/year

56

**DIVIDE THE TOTAL COST FROM THE TOTAL  
FOOTAGE OF LINE THAT WAS WORK ON**

$$\frac{\text{Total cost}=\$262,300.00}{\text{Total footage}=792,000\text{ft.}} =$$

**0.331**

57

**QUESTION # 68**

**ANSWER**

**0.33**

58

## QUESTION # 68

- Determine what need to be done
  - How many workers did it take to do the job (cleaning)
  - What was the annual cost for the workers
  - What was the annual cost of the equipment
  - How many feet of line was worked on that year
- Take the total cost of the workers and equipment, add them together
- Divide the total cost from the total footage of line that was work on
- Equals unit cost, in dollars per foot

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## QUESTION # 74

An 8 inch diameter force main serves 1,837 homes.

For estimating purposes, there are 2.6 people per home and per capita use is 100 gallons per day. What is the average flow velocity in feet per second?

60

## QUESTION # 74

What does the term

“per capita”

means?

**BY OR FOR EACH PERSON**

61

## QUESTION # 74

- $8\cancel{\text{in}} / 12\cancel{\text{in}} = 0.667\text{ft.}$
- $0.667 \times 0.667 \times 0.785 = 0.349\text{sqft}$
- $2.6 \frac{\cancel{\text{people}}}{\text{home}} \times \frac{100\cancel{\text{gpd}}}{\cancel{\text{person}}} = 260 \frac{\text{gpd}}{\text{home}}$
- $260 \frac{\cancel{\text{gpd}}}{\cancel{\text{home}}} \times 1,837 \cancel{\text{homes}} = 477,620\text{gpd}$
- $477,620\cancel{\text{gpd}} / 1440\cancel{\text{mpd}} = 331.68\text{gpm}$
- $331.68\cancel{\text{gpm}} / 60\cancel{\text{spm}} = 5.528\text{gps}$

62

### QUESTION # 74

- $5.528\cancel{\text{gps}}/7.48\cancel{\text{gpcf}} = 0.739\text{cfs}$

- $0.739\cancel{\text{cfs}}/0.349\cancel{\text{sqf}} = 2.12\text{fps}$

63

### QUESTION # 74

ANSWER

**2.1feet/second**

64

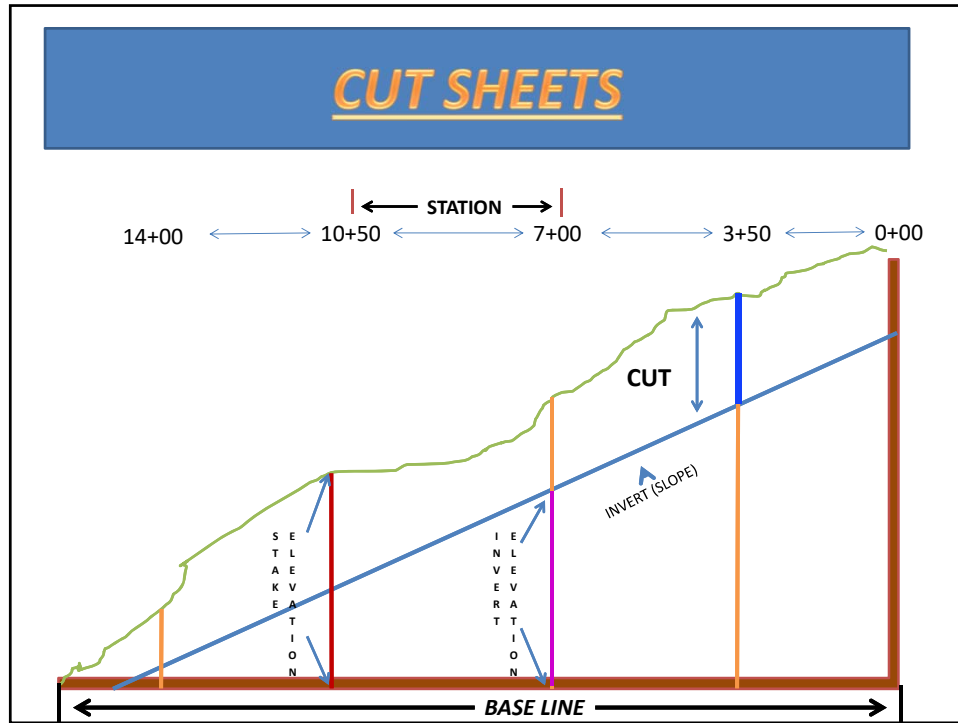




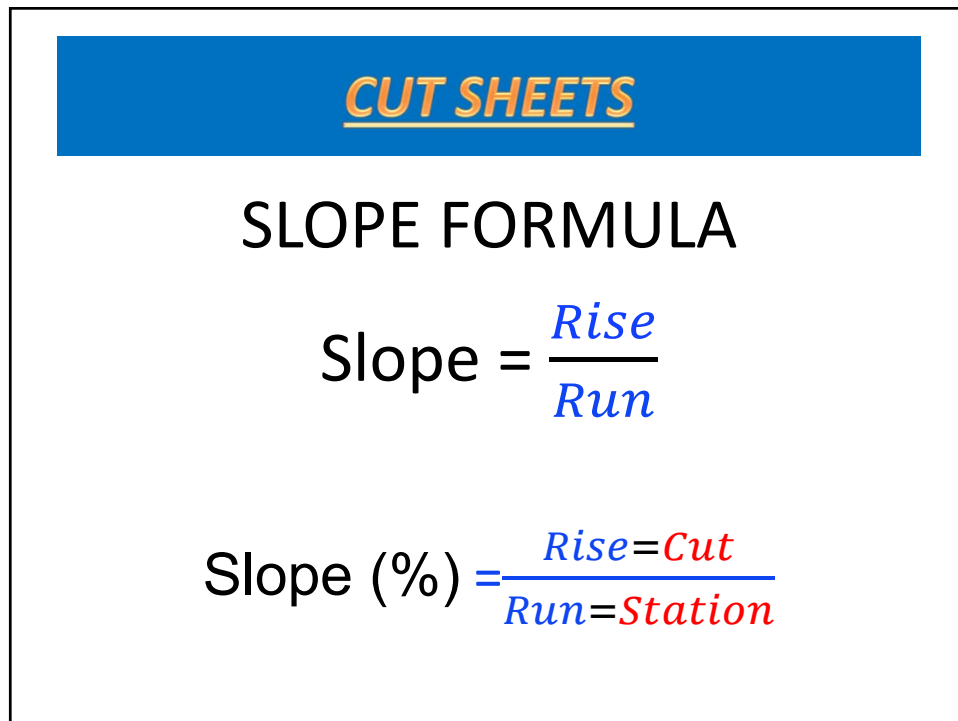
65

<b><u>CUT SHEETS</u></b>				
STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

66



67



68

## CUT SHEETS

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$

$$\text{Run} = \frac{\text{Rise}}{\text{Slope}}$$

$$\text{Rise} = (\text{Run}) (\text{Slope})$$

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## CUT SHEETS

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2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

1. Box G, in cut sheet A should read:

- a. No
- b. Yes
- c. Maybe
- d. None of the above

70

## CUT SHEET

1. To know if shoring is required you need to know what the cut (depth) is.
2. On this sheet the Cut depth is given to us at **8.90ft.**  
Any cut of **5ft.** or more needs shoring.
3. **8.90ft.** Is more then **5ft.** So, the answer is

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
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2+88	1201.50	<b>C</b>	<b>E</b>	Yes
3+68	1199.14	1195.80	<b>F</b>	<b>I</b>

1. Box G, in cut sheet A should read:
  - a. No
  - b. Yes**
  - c. Maybe
  - d. None of the above

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## CUT SHEETS

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2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

2. Using the cut sheet above , calculate the value for box F.

- a. 5.34
- b. 4.43
- c. 3.34
- d. 4.40

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## CUT SHEETS

To find the answer for  
box F, you take the stake elevation

1199.14ft.

and subtract the invert elevation

1195.80ft.

That

will give you the cut depth

(3.34ft.).

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## CUT SHEETS

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1+38	1205.22	1194.88	10.34	Yes
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A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

3. Using the cut sheet above , find the cut sheet slope, in decimal form

- a. 1.04ft
- b. 0.004ft
- c. 250.00ft
- d. 0.040ft

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## CUT SHEETS

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$

By using the Slope Formula (  $\frac{\text{Rise}}{\text{Run}}$  ) We can find the Slope.

1. Take the First Two Invert Elevation From the Chart and Subtract Them. This will give you your Rise that you need .

$$1195.08 - 1194.88 = 0.20 \text{ (Rise)}$$

2. Take the First Two Stations on the Chart and Subtract Them. This Will Give You Your Run That You Need.

$$1+88 \text{ (188)} - 1+38 \text{ (138)} = 50 \text{ (Run)}$$

3. As In The Formula Take the Rise (0.20) Divide by the Run (50) This Will Give You Your Slope 0.004

$$\frac{0.20 \text{ (Rise)}}{50 \text{ (Run)}} = 0.004$$

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## CUT SHEETS

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1+38	1205.22	1194.88	10.34	Yes
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2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

3. Using the cut sheet above , find the cut sheet slope, in decimal form

- a. 1.04ft
- b. **0.004ft**
- c. 250.00ft
- d. 0.040ft 3

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

4. Using the cut sheet above, find the value for box A.
- 2+58
  - 2+18
  - 2+98
  - 2.98

79

## CUT SHEETS

$$\text{Run} = \frac{\text{Rise}}{\text{Slope}}$$

With this question we need to find the **Run**

- We need to Subtract the **Invert Elevation** that is above the **Invert Elevation** on the same line of **box A** to find the **Rise**.

$$1195.20 - 1195.08 = 0.12 \text{ (Rise)}$$

- We have the **Slope (0.004)** from Question 3

- Take the **Rise** and Divide by the **Slope** you'll have your **Run**

$$\frac{0.12 \text{ (Rise)}}{0.004 \text{ (Slope)}} = 30$$

- Take the Station (**1+88**) that is above Box A Add the **Run (30)** to get the Missing Station in Box A

$$188 \text{ (1+88)} + 30 \text{ (Run)} = 218 \text{ (2+18)} \text{ The Missing Station}$$

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

4. Using the cut sheet above, find the value for box A.
- 2+58
  - 2+18**
  - 2+98
  - 2.98

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

5. Box I, in the cut sheet A, should read?
- No
  - Yes
  - Maybe Yes, depending on soil conditions,
  - None of the above.

82

## CUT SHEETS

The question is if shoring is require for box I.

To find this out we need to know some facts.

1. How deep is the cut in box F.

To find the depth of the cut you need to Subtract the **Invert Elevation** from the **Stake Elevation** to get the cut depth.

**1199.14 (Stake Elevation) - 1195.80 (Invert Elevation) = 3.34ft. (Cut).**

2. What are the soil conditions

Even though the depth (**Cut**) is less then 5ft. The soil conditions might required you to use shoring

Your answer should be

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	<b>B</b>	1195.08	8.90	<b>G</b>
<b>A</b>	1203.21	1195.20	<b>D</b>	Yes
2+38	1202.74	1195.28	7.46	<b>H</b>
2+88	1201.50	<b>C</b>	<b>E</b>	Yes
3+68	1199.14	1195.80	<b>F</b>	<b>I</b>

5. Box I, in the cut sheet A, should read?

- a. **No**
- b. **Yes**
- c. **Maybe Yes, depending on soil conditions,**
- d. **None of the above.**

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

6. Using the cut sheet above, calculate the value for Box C?

- 1195.56
- 1195.46
- 1195.52
- 1195.48

85

## CUT SHEETS

$$\text{Rise} = (\text{Run}) (\text{Slope})$$

With this question we need to find the **Rise** to find out what the Invert Elevation for box C will be.

- Need to find the **Run** by taking station 2+88 ( on the same line of box C ), and subtract station 2+38 ( the line above station 2+88 ) this will give you the **Run** part that you need.  

$$2+88 (288) - 2+38 (238) = 50\text{ft.}$$
- Take the **Slope** (0.004) that we found in the question 3 and Multiply by the **Run** (50), and that will give you the **Rise** that you will need  

$$0.004 (\text{Slope}) \times 50\text{ft.} (\text{Run}) = 0.2 (\text{Rise})$$
- Take the Invert Elevation (1195.28) and add the **Rise**. This will give you the **Invert Elevation** for **Box C**.  

$$1195.28 + 0.2 = 1195.48$$

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

6. Using the cut sheet above, calculate the value for Box C?

- a. 1195.56
- b. 1195.46
- c. 1195.52
- d. 1195.48**

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

7. Using the Cut Sheet above, calculate the value for Box D?

- a. 8.01
- b. 8.10
- c. 8.09
- d. 8.00**

88

## CUT SHEETS

Need to find the **Cut (Depth)** for **Box D**

Subtract the *Invert Elevation* from the *Stake Elevation*

1203.21 (*Stake Elevation*)

-1195.20 (*Invert Elevation*)

**8.01 (Cut)**

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	<b>B</b>	1195.08	8.90	<b>G</b>
<b>A</b>	1203.21	1195.20	<b>D</b>	Yes
2+38	1202.74	1195.28	7.46	<b>H</b>
2+88	1201.50	<b>C</b>	<b>E</b>	Yes
3+68	1199.14	1195.80	<b>F</b>	<b>I</b>

7. Using the Cut Sheet above, calculate the value for Box D?

- a. **8.01**
- b. 8.10
- c. 8.09
- d. 8.00

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

8. Using to Cut Sheet above, calculate the value for Box B?
- 1203.98
  - 1204.25
  - 1204.37
  - 1203.72

91

## CUT SHEETS

Need to find the *Stake Elevation* for Box B

To find the *Stake Elevation* take the *Invert Elevation*  
and add the *Cut* to get your *Stake Elevation*

$$\begin{array}{r}
 1195.08 \text{ (Invert Elevation)} \\
 + 8.90 \text{ (Cut)} \\
 \hline
 1203.98 \text{ (Stake Elevation)}
 \end{array}$$

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

8. Using to Cut Sheet above, calculate the value for Box B?

- a. **1203.98**  
 a. 1204.25  
 b. 1204.37  
 c. 1203.72

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

9. Using the Cut Sheet above, calculate the value for Box E ?

- a) 5.98  
 b) 5.36  
 c) 6.02  
 d) 6.00

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## CUT SHEETS

1. Need to find the *Invert Elevation* for the C Box. We can refer back to Question # 6 to find that answer. There we find that the *Invert Elevation* is 1195.48
2. Take the *Stake Elevation* (1201.50), and Subtract the *Invert Elevation* (1195.48). This will give you your *Cut* for Box E.

$$\begin{array}{r}
 1195.48 \text{ (Invert Elevation)} \\
 -1201.50 \text{ (Stake Elevation)} \\
 \hline
 6.02 \text{ (Cut)}
 \end{array}$$

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## CUT SHEETS

STATION	Stake Elev. (Elevation at Existing Grade)	Invert Elevation	Cut	Shoring Required
1+38	1205.22	1194.88	10.34	Yes
1+88	B	1195.08	8.90	G
A	1203.21	1195.20	D	Yes
2+38	1202.74	1195.28	7.46	H
2+88	1201.50	C	E	Yes
3+68	1199.14	1195.80	F	I

9. Using the Cut Sheet above, calculate the value for Box E ?
- a) 5.98
  - b) 5.36
  - c) **6.02**
  - d) 6.00

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