WEF Operations Challenge
Process Control Event
2016

Team Name: _____

Team Number: _____

Team Captain: _____

Test points awarded: _____

Simulator points awarded: _____

Total event points: _____

Multiple choice section
- 5 pages
- 30 total questions
- 10 to 20 points per question

Extended multiple choice section
- 2 pages
- 10 total questions
- 25 to 50 points per question

Math multiple choice section
- 2 pages
- 10 total questions
- Up to 50 points per question
- 50% partial credit possible
- **0 points if work not shown**

Process scenarios section
- **Questions may have differing point values**
- up to 180 points per correct answer and work shown
- 50% partial credit possible
- **0 points if work not shown**

Remember that you may be penalized if you don't show your work, even if the answer is correct!

All team members must participate

Multiple Choice

Circle the ***best*** answer for each question from the choices provided.

Each correct answer on this page is worth 10 points

#	Question	Choices		For grader's use: Points	For grader's use: Proper answer
1	The typical operation depth for digesters is approximately how many feet?	A	5 ft (*1.5 m*)	10	B
		(B)	20 ft (*6 m*)		
		C	50 ft (*15 m*)		
		D	80 ft (*24 m*)		
2	Screening devices are designed to remove _____.	A	dissolved solids	10	C
		B	grit particles		
		(C)	trash solids		
		D	settleable solids		
3	The adverse effect a substance has on a living entity defines that substance's _____.	(A)	toxicity	10	A
		B	alkalinity		
		C	acidity		
		D	demand		
4	How is phosphorus removed from wastewater?	A	air stripping	10	D
		B	breakpoint chlorination		
		C	methanol addition		
		(D)	chemical addition and sedimentation/filtration		
5	If a hazardous gas has a specific gravity of 1.5, where is this gas likely to be found if it leaks from a container in a room?	(A)	near the floor	10	A
		B	equally distributed throughout the space		
		C	near the ceiling		
		D	in a cloud right around the leak		
6	Waste activated sludge is typically _____ raw primary sludge.	A	thicker than	10	B
		(B)	thinner than		
		C	the same as		
		D	more dense than		

Multiple Choice

Circle the ***best*** answer for each question from the choices provided.

Each correct answer on this page is worth 10 points

For grader's use	
Points	Proper answer

#	Question	Choices		Points	Proper answer
7	Ultraviolet disinfection is becoming more popular because UV systems	A	Create disinfection byproducts		
		B	Conserve energy		
		C	Require no maintenance	10	D
		D	Eliminate safety concerns about handling chlorine		
8	Ultraviolet lamps contain which of the following hazardous substances?	A	Hydrogen sulfide		
		B	Chlorine gas		
		C	Mercury vapor	10	C
		D	Methane		
9	What name is given to the material floating on the surface of clarifiers and other settling tanks?	A	grit		
		B	scum		
		C	trash	10	B
		D	screenings		
10	The vertical distance through which a liquid is to be pumped is referred to as_____.	A	specific speed		
		B	displacement		
		C	pressure	10	D
		D	head		
11	The gas produced in an anaerobic digester that can be used as a fuel is _____.	A	methane		
		B	ethane		
		C	carbon dioxide	10	A
		D	propane		
12	Most of the major odorous gases contain which element?	A	iron (Fe)		
		B	sulfur (S)		
		C	magnesium (Mg)	10	B
		D	iodine (I)		

Multiple Choice

Circle the ***best*** answer for each question from the choices provided.

Each correct answer on this page is worth 10 points

#	Question	Choices		For grader's use: Points	For grader's use: Proper answer
13	When it comes to hazards of a specific chemical, the best source of information is _____.	A	Your safety officer	10	C
		B	An OSHA representative		
		C	SDS (Safety Data Sheet) formerly MSDS		
		D	your supervisor		
14	What document is intended to regulate discharges into waterways?	A	Comprehensive Environmental Response, Compensation & Liability Act (CERLA)	10	B
		B	National Pollutant Discharge Elimination System (NPDES)		
		C	Material Safety Data Sheet (MSDS)		
		D	Occupational Safety and Health Act (OSHA)		
15	In anaerobic digestion, what explosive gas is formed?	A	carbon dioxide	10	D
		B	ammonia		
		C	hydrogen sulfide		
		D	methane		
16	Nitrogen and _____ are essential nutrients for microbial growth.	A	chlorine	10	B
		B	phosphorus		
		C	sulfur		
		D	boron		
17	When sludge does not settle properly, the condition is typically referred to as _____.	A	denitrification	10	C
		B	nitrification		
		C	bulking		
		D	blowdown		
18	A limiting factor for digester loading is _____.	A	sludge color	10	D
		B	pathogen type		
		C	pathogen content		
		D	hydraulic detention time		

Multiple Choice

Circle the ***best*** answer for each question from the choices provided.

Each correct answer on this page is worth 20 points

For grader's use	
Points	Proper answer

#	Question		Choices		
19	Which of the following is NOT an inorganic conditioner?	A	ferric chloride		
		B	calcium oxide		
		C	polymer	20	C
		D	calcium hydroxide		
20	Most gas piping systems are rated for _____service.	A	700 kPa (100 psi)		
		B	1050 kPa (150 psi)	20	B
		C	350 kPa (50 psi)		
		D	1500 kPa (200 psi)		
21	In an extended aeration activated sludge process, the solids retention time (SRT) is _____ ?	A	40 - 60 days		
		B	2 - 8 days		
		C	8 - 15 days	20	D
		D	15 - 40 days		
22	What is the typical cause of ponding on a trickling filter?	A	excessive biological growth on the media		
		B	foreign material		
		C	insufficient filter wetting	20	A
		D	insufficient ventilation		
23	A pH drop in an aerobic digester can be caused by _____.	A	organic underloading		
		B	nitrification or CO_2 buildup		
		C	clogging of diffusers	20	B
		D	hydraulic overloading		
24	The maximum rate for withdrawing gaseous chlorine from a 1-ton tank at room temperature (70F or 21C).	A	7 lbs/hr (*3 kg/hr*)		
		B	10 lbs/hr (*4.5 kg/hr*)		
		C	15 lbs/hr (*7 kg/hr*) MOP 11	20	C
		D	20 lbs/hr (*9 kg/hr*)		

Multiple Choice

Circle the ***best*** answer for each question from the choices provided.

Each correct answer on this page is worth 20 points

For grader's use	
Points	Proper answer

#	Question		Choices	Points	Proper answer
25	The destabilization of sludge particles by decreasing the repulsive forces between particles is called _____.	A	equalization	20	D
		B	flocculation		
		C	neutralization		
		D	coagulation		
26	In an aerated lagoon, the minimum dissolved oxygen level that must be maintained is _____ ?	A	1 mg/L	20	A
		B	2 mg/L		
		C	3 mg/L		
		D	4 mg/L		
27	The two design configurations typically available for solid-bowl centrifuges are _____.	A	horizontally and vertically opposed	20	D
		B	gravity and high-pressure		
		C	recessed plate and diaphragm		
		D	concurrent and countercurrent		
28	The wavelength of UV light used to disinfect wastewater effluent is _____.	A	253.7 nm	20	A
		B	274.9 nm		
		C	286.5 nm		
		D	225.2 nm		
29	If involved in a fire, which one of the following chemicals would be considered a Class D fire?	A	Paper	20	D
		B	Oil		
		C	Electrical Equipment		
		D	Magnesium		
30	If your RAS flow is too high, what is typically the primary result?	A	aeration in the basin would increase	20	D
		B	anaerobic conditions would develop in your secondary clarifier		
		C	the solids level to the final effluent decreases		
		D	solids could overload the clarifier		

Extended Multiple Choice

Each correct answer on this page is worth **25** points

Enter the letter corresponding to the ***best*** answer in the box provided for each question

For grader's use	
Points (25)	Proper answer

Choices	
A	acid and water at the same time
B	acid into a container containing water
C	activated sludge
D	anaerobiasis
E	ashing
F	bulking
G	clarifier
H	colloids
I	disinfection system
J	double stack
K	filter
L	fluidized bed
M	induced draft
N	It does not matter
O	multiple-hearth
P	overland flow
Q	rotating biological contactors
R	screen
S	trickling filters
T	water into a container containing acid.

#	Question	Answer	Points (25)	Proper answer
1	When diluting acids with water the proper technique is to pour _____.	B	25	B
2	What type of treatment process typically includes aeration basins and mixed liquor?	C	25	C
3	Before wastewater treatment begins, flow typically passes through a _____.	R	25	R
4	Which type of incinerator uses graded silica?	L	25	L
5	An excessive amount of small, light particles floating on the surface of a secondary clarifier is referred to as _____.	E	25	E

Extended Multiple Choice

150
75
225

Each correct answer on this page is worth **50** points

Enter the letter corresponding to the ***best*** answer in the box provided for each question

For grader's use	
Points (50)	Proper answer

Choices	
A	aeration basins
B	anaerobic conditions within the filter
C	coagulation
D	dechlorination
E	digestion
F	dilution
G	disinfection
H	dissolved air flotation
I	gravity thickening
J	odor control
K	pH control
L	polishing ponds
M	primary sedimentation
N	rotating biological contators
O	sand filtration
P	sterilization
Q	the clogging of distributor arm orifices
R	the presence of the Psychoda fly
S	too much recirculation
T	trickling filtration

#	Question	Answer		
6	An aerobic pond with a detention time of 3 days would provide treatment comparable to _____.	M	50	M
7	Potassium permanganate is typically used for _____ in wastewater treatment.	J	50	J
8	Which treatment unit is dependent on suspended bacteria for efficiency?	A (E)	50	A, E
9	A "rotten egg" odor near a trickling filter generally indicates _____.	B	50	B
10	The destruction of the larger portion of microorganisms with the probability that all pathogens are killed is called _____.	G	50	G

Math Multiple Choice

You must show your work (i.e. formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Each correct answer on this page is worth **30** points

For grader's use	
Points (15/30)	Proper answer

#	Question		Choices		
1	A clarifier is 50 ft. (*15.2 m*) in diameter and 12 feet (*3.6 m*) deep. How many gallons (*liters*) does it hold? (ignore the sloped bottom) $(\frac{50}{2})^2 \pi \times 12 \times 7.48 = 17624.3$ gal $(\frac{15.2}{2})^2 \pi \times 3.6 \times 1000 = 653250$ L	A	195000 gal (*740000 liters*)	30	C
		B	700000 gal (*2650000 liters*)		
		C	175000 gal (*650000 liters*)		
		D	56000 gal (*210000 liters*)		
2	An operator knows that the plant must remove at least 85% of the BOD coming in. If the influent BOD is 189 mg/l, what must the effluent BOD be less than? $189 \times 0.85 = 160.65$ $189 - 160.65 = 28.35$	A	28 mg/l	30	A
		B	160 mg/l		
		C	20 mg/l		
		D	104 mg/l		
3	The BOD level of the wastewater entering an aeration tank is 220 mg/L. If the flow to the tank is 1.65 MGD (*72.3 l/s*), what is the lbs/day (*kg/day*) of BOD loading? $220 \times 8.34 \times 1.65 = 3027.42$ lbs $\frac{72.3 \times 60 \times 60 \times 24 \times 220}{1,000,000} = 1374.2784$ kg	A	3596 lbs/day (*1631 kg/day*)	30	D
		B	4515 lbs/day (*2048 kg/day*)		
		C	5299 lbs/day (*2403 kg/day*)		
		D	3027 lbs/day (1374 kg/day)		
4	1 cu ft/sec is equal to _____. $1 \times 7.48 \times \frac{60}{1} = 448.8$ gpm $\times 60$ 26928 gph $\times 24 / 1,000,000 = 0.6463$ MGD	A	0.72 mgd	30	D
		B	500 gpm		
		C	30024 gph		
		D	0.65 mgd		
5	If a solids sample is 5% solids, what is the concentration in mg/L? $5\% \times 10,000 = 50,000$	A	500 mg/L	30	D
		B	5,000 mg/L		
		C	50 mg/L		
		D	50,000 mg/L		

Math Multiple Choice

You must show your work (i.e. formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Each correct answer on this page is worth **50** points

For grader's use	
Points (25/50)	Proper answer

#	Question		Choices	Points	Proper answer
6	A magnetic flow meter measured 5000 gal (*19000 liters*) of raw solids pumped. The solids pumped were 6.1% total solids. How many pounds (*kg*) of dry solids were handled? $0.005 \times 8.34 \times 6.1 \times 10000 = 2543.7$ lb $\frac{19000 \times 6.1 \times 10,000}{10,000} = 1159$ kg	A	1581 lb (*717 kg*)	50	C
		B	2281 lb (*1035 kg*)		
		C	2544 lb (*1159 kg*)		
		D	3657 lb (*1659 kg*)		
7	A plant has a 90 foot (*27.5 m*) diameter sludge tank with a side-wall depth of 20 feet (*6.1 m*). The tank also has a conical bottom that is 8 feet (*2.4 m*) deep. The tank has a sludge level of 15 feet (*4.6 m*) (SWD). How many gallons (*liters*) of sludge liquid are in the tank? $\left(\frac{90}{2}\right)^2 \pi \left(15 + \frac{8}{3}\right) \times 7.48 = 840650$ gal $\left(\frac{27.5}{2}\right)^2 \pi \left(4.6 + \frac{2.4}{3}\right) = 3207.37 m^3$	A	587,000 gals (*2220 m^3*)	50	C
		B	713,000 gal (*2700 m^3*)		
		C	840,0005 gal (*3210 m^3*)		
		D	1,094,000 gal (*4140 m^3*)		
8	What approximate horsepower (*kW*) motor is required for a pump discharge of 1000 gpm (*63 l/sec*) at 110 psi (*758 kPa*)? Assume the pump and motor are 100% efficient. $\frac{1000 \times (110 \times 2.31)}{3960} = 64.16$ hp $\frac{63 \times 60 \times 758}{60,000} = 47.4$ kW	A	25 HP (*15 kW*)	50	C
		B	50 HP (*40 kW*)		
		C	75 HP (*50 kW*)		
		D	100 HP (*75 kW*)		
9	A total chlorine dosage of 6.9 mg/L is required for disinfection. If the effluent flow is 3.1 MGD (*136 l/sec*) and the hypochlorite used has 65% available chlorine, how many pounds /day (*kg/day*) of hypochlorite will be required? $\frac{3.1 \times 8.34 \times 6.9}{0.65} = 274.4$ lbs $\frac{136 \times 60 \times 1440}{1,000,000} \times 6.9 \times \frac{1}{0.65} = 124.7$ kg	A	512 lbs/day (*232 kg/day*)	50	C
		B	158 lbs/day (*71.7 kg/day*)		
		C	274 lbs/day (*125 kg/day*)		
		D	395 lbs/day (179 kg/day)		
10	A 250 foot (*76 m*) long pipe 12 inches (300 mm) in diameter holds how many gallons (*liters*) of water when full? $\left(\frac{12}{\frac{12}{2}}\right)^2 \pi \times 250 \times 7.48 = 1468.69$ gal $\left(\frac{0.300}{2}\right)^2 \pi \times 76 \times 1000 = 5372$ L	A	196 gal (*742 liters*)	50	B
		B	1470 gal (*5370 liters*)		
		C	5870 gal (*22200 liters*)		
		D	1640 gal (*6210 liters*)		

Bourbon Street Wastewater Treatment Plant is a 50 MGD (*131.4 m^3/min*) design, trickling filter (TF) plant. The plant has primary clarifiers ahead of 4 separate trains of a two stage TF system. Each two stage TF train has a roughing filter for the first pass followed by a high rate filter capable of nitrification. Each TF train has recirculation capabilities where effluent from the high rate filter is designed for recirculation rate of up to a 1:1 ratio (in relation to influent flow) to the influent pump station of the roughing filter. All TFs are identical in size at 100' (*30.5 m*) diameter and 20' (*6.1 m*) media depth each with a 4 arm distributor mechanism. The roughing filters contain plastic media with a surface area of 31 sq ft/cu ft (*102 m^2/m^3*) of media with a design BOD loading of 150 lbs/day/1000 cu ft (*2.4 $kg/m^3/d$*) while the high rate filter's plastic media is 48 sq ft/cu ft (*157.5 m^2/m^3*) of media with a design BOD loading of 25 lbs/day/1000 cu ft (*0.4 $kg/m^3/d$*). Primary effluent data is measured at the confluence of the primary clarifier launders.

Plant Operating Information	
Daily flow	30 MGD (*113,560 m^3/d*)
Influent BOD	240 mg/l
Influent TSS	225 mg/l
Influent NH_3	25 mg/l
Primary Effluent BOD	135 mg/l
Primary Effluent TSS	90 mg/l
Primary Effluent NH_3	30 mg/l
Final Effluent BOD	8 mg/l
Final Effluent TSS	12 mg/l
Final Effluent NH_3	0.5 mg/l
Current Recycle Ratio	0.5
TF Trains on line	3

TABLE 1A (Standard Units)		TABLE 1B (Metric Units)	
BOD5 loading - lbs/day/1000 cu ft	Design SK rate range (mm/pass)	BOD5 loading $kg/day/m^3$	Design SK rate range (mm/pass)
< 25	15-40	<0.41	15-40
50	25-75	0.8	25-75
75	40-120	1.2	40-120
100	50-150	1.6	50-150
120	60-180	1.9	60-180
150	75-225	2.4	75-225

Scenario #1: Trickling Filters

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

C - B - C - B

1

Maximum point value for this question: **90**

Under plant operating conditions and assuming an equal flow split from the primary clarifiers and considering primary effluent data, what is the organic loading on the roughing filters?

A	47.8 lbs BOD/1000 cu ft (*0.77 kg/m^3*)
B	53.8 lbs BOD/1000 cu ft (*0.86 kg/m^3*)
(C)	71.7 lbs BOD/1000 cu ft (*1.15 kg/m^3*)
D	127.5 lbs BOD/1000 cu ft (*2.04 kg/m^3*)
E	382.5 lbs BOD/1000 cu ft (*6.13 kg/m^3*)

$\left(\frac{100}{2}\right)^2 \frac{\pi}{11} \times 20 = 157079 \text{ ft}^3 \text{ each}$

$30 \times 8.34 \times 135 = 33777 \text{ lbs}$

$\frac{33777}{(157 \times 3)} = 71.7$

$\left(\frac{30.5}{2}\right)^2 \frac{\pi}{11} \times 6.1 = 4456.76 \text{ m}^3 \text{ each}$

$\frac{113,560 \times 135}{1000} = 15330.6 \text{ kg}$ $\quad \frac{15330.6}{3 \times 4456.76} = 1.1466$

For grader's use only
Proper answer: C
Points earned: 90

Scenario #1: Trickling Filters

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

2

Maximum point value for this question: **90**

Under plant operating conditions and assuming an equal flow split from the primary clarifiers, what is the wetting rate on the high rate TFs as defined by the cross sectional area?

A	1273 gpd/sq ft ($15.9\ m^3/m^2/d$)
B	1911 gpd/sq ft ($77.9\ m^3/m^2/d$)
C	4770 gpd/sq ft ($194.3\ m^3/m^2/d$)
D	5732 gpd/sq ft ($233.5\ m^3/m^2/d$)

$30\ MGD + 0.5 \times 30 = 45\ MGD$

$\left(\frac{100}{2}\right)^2 \times \frac{1}{11} = 7854\ ft^2\ each$

$\frac{45{,}000{,}000\ gpd}{7854 \times 3} = 1909.85$

$113560 \times 1.5 = 170340\ m^3/d$

$\left(\frac{30.5}{2}\right)^2 \times \frac{1}{11} = 730.617\ m^2\ each$

$\frac{170340}{730.6 \times 3} = 77.715$

For grader's use only

Proper answer: B

Points earned: 90

Scenario #1: Trickling Filters

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

3

Maximum point value for this question: **180**

If the distribution arms on the high rate TFs rotate at 2 rpm, what is the current Spulkraft flushing intensity (SK) rate? Again, assume equal flow splitting from the primary clarifiers.

A	19.71 mm/pass
B	13.51 mm/pass
(C)	6.76 mm/pass
D	4.50 mm/pass

$30 \times 1.5 = 45$ mgd

$\frac{45,000,000}{1440} = 31250$ gpm

$\left(\frac{100}{2}\right)^2 \pi = 7854$ ft^2

$SK = \frac{25.4 \times \frac{31250}{7.48} \times 12}{7854 \times 3 \times 4 \times 2} = 6.755$

$113560 \times 1.5 = 170340$ m^3/d

$\frac{170340}{24} = 7097.5$ m^3/hr

$\left(\frac{30.5}{2}\right)^2 \pi = 730.6$ m^2 each

$SK = \frac{\frac{7097.5}{(730.6 \times 3)} \times 1000}{4 \times 2 \times 60} = 6.746$

For grader's use only
Proper answer: C
Points earned: 180

Scenario #1: Trickling Filters

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

4

Maximum point value for this question: **210**

Using the Spulkraft flushing intensity (SK) rate information on Table 1 attached, if the primary clarifier effluent BOD increases to 190 mg/l, what is the maximum distribution arm speed (in RPM) that should be targeted if all four roughing filters are on line?

A	0.08 RPM
B	0.25 RPM
C	0.46 RPM
D	0.63 RPM

190 × 8.34 × 30 = 47538 lbs

157 × 4 = 628 kft³

47538 / 628 = 75.7 lb/kft³

SK = 40 mm/pass

(31250 × 12 × 25.4) / (7854 × 4 × 4 × 7.48 × 40) = 0.253

(190 × 113560) / 1000 = 21576.4 kg

21576.4 / 17828 = 1.21 kg/m³

SK = 40

4457 × 4 = 17828 m³

113560 × 1.5 / 24 = 7097.5 m³/hr

7097.5 / 730.6 × 4 = 2.428 m³/m²/hr

(2.428 × 1000) / (4 × 40 × 60) = 0.253

Hint SK = mm/pass = (flow in m3/m2/hr * 1000 mm/m)/(number of arms * RPM * 60 min/hr)
Hint SK = mm/pass = 25.4*(gpm*12/7.48)/(area*# of arms*rpm)

For grader's use only

Proper answer: B

Points earned: 210

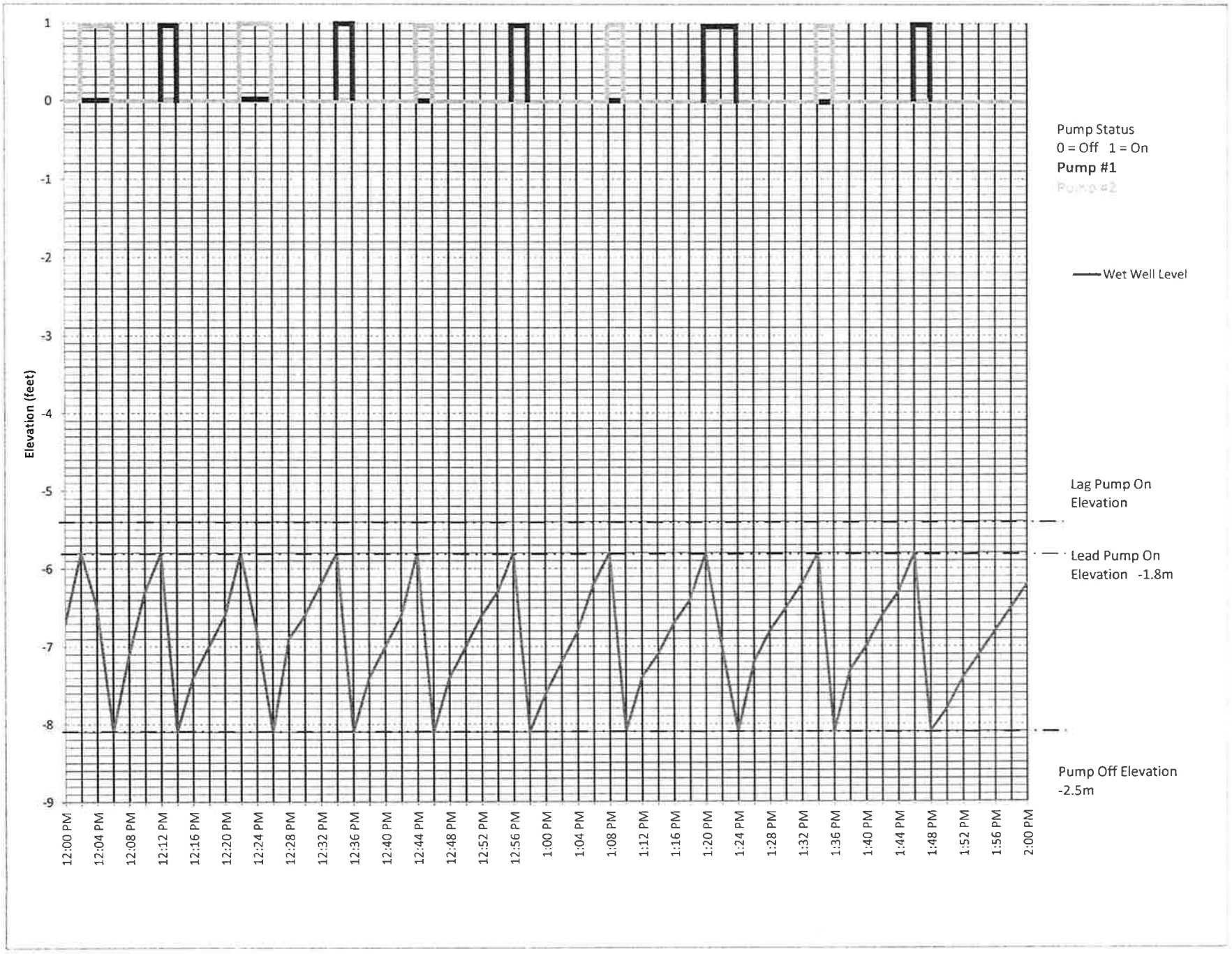
Scenario #3 Lift Station Data

Below are the characteristics of the 24th Street Pumping Station. This is a duplex pumping station where the pumps alternate between lead and lag duty. Please use the below characteristics and the attached SCADA Graph to answer any questions. All elevations are in reference of mean sea level (i.e. 0 is mean sea level)

Basin Characteristics	
Total Basin Area	135.5 ac (*55 ha*)
Sewered Basin Area	91.7 ac (*37 ha*)
Base Sewage Flow	0.104 mgd (*393.7 m^3/d*)
Water Consumption	0.104 mgd (*393.7 m^3/d*)
Dry Weather Infiltration	0.143 mgd (*541.3 m^3/d*)
Average Daily Flow	0.247 mgd (*935.0 m^3/d*)
2-year Peak Sewer Flow	1.06 mgd (*4012 m^3/d*)
5-year Peak Sewer Flow	1.34 mgd (*5072 m^3/d*)
10-year Peak Sewer Flow	1.53 mgd (*5792 m^3/d*)

Wet Well Parameters	
Width	7 ft (*2.1 m*)
Length	11 ft (*3.4 m*)
Top of Top Slab Elevation	5.9 ft (*1.8 m*)
Thickness of Top Slab	0.7 ft (*0.21 m*)
Top of Bottom Slab Elevation	-11.3 ft (*-3.4 m*)
Thickness of Bottom Slab	1.0 ft (*0.30 m*)
Influent Line Invert Elevation	-5.3 ft (*-1.6 m*)
Influent Line Diameter	16 inch (*400 mm*)

Pump 1 and 2 Information	
Discharge Size	8 in (*200 mm*)
Maximum Pump Rate Per Pump	1050 gpm (*3.98 m^3/min*)
Ultimate Buildout Design Total Dynamic Head	158 ft (*48.16 m*)
Design RPM	1800
Current Buildout Design Total Dynamic Head	92 ft (*159 m^3/d*)


Elevation (feet)
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
12:00 PM
12:04 PM
12:08 PM
12:12 PM
12:16 PM
12:20 PM
12:24 PM
12:28 PM
12:32 PM
12:36 PM
12:40 PM
12:44 PM
12:48 PM
12:52 PM
12:56 PM
1:00 PM
1:04 PM
1:08 PM
1:12 PM
1:16 PM
1:20 PM
1:24 PM
1:28 PM
1:32 PM
1:36 PM
1:40 PM
1:44 PM
1:48 PM
1:52 PM
1:56 PM
2:00 PM
Pump Status
0 = Off 1 = On
Pump #1
Pump #2
Wet Well Level
Lag Pump On Elevation
Lead Pump On Elevation -1.8m
Pump Off Elevation -2.5m

Scenario #3: Lift Station

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

1

Maximum point value for this question: **60**

What is the maximum volume of the wet well only not including any potential storage in the gravity collection system?

$7 \times 11 \times (5.9 - 0.7 - (-11.3)) = 1270.5\ ft^3$

1270.5
× 7.48
9503.3 gal

$2.1 \times 3.4 \times (1.8 - 0.21 - (-3.4)) = 35.629\ m^3$

× 1000
35629 L

A	1271 gal	(*4810 liters*)
B	3513 gal	(*13300 liters*)
C	6508 gal	(*24600 liters*)
(D)	9503 gal	(*35970 liters*)

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Proper answer: D

Points earned: 60

Scenario #3: Lift Station

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

2

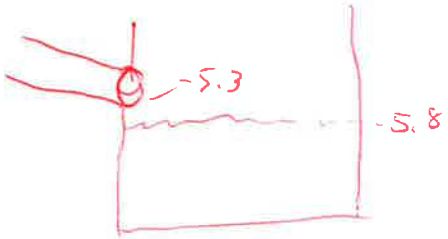
Maximum point value for this question: **50**

Given the current operating parameters as shown in the SCADA chart is the wet well surcharging the gravity collection system in any way? (support your answer)

A	Yes
B	No
C	Sometimes

wet well max = -5.8

invert = -5.3



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Proper answer: B

Points earned: 50

Scenario #3: Lift Station

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

3

Maximum point value for this question: **100**

Utilizing the SCADA chart which pump is operating between between 12:4~~8~~4 PM and 12:56 PM? What is the calculated pump discharge assuming inflow is average daily flow?

$8.1' - 5.8' = 2.3'$ drawdown

$7 \times 11 \times 2.3 \times 7.48 = 1324.7$ gal drawdown

$\frac{1324.7}{2} = 662.35$ gpm

$\frac{0.247 \times 1{,}000{,}000}{24 \times 60} = 171.5$ gpm

$662.35 + 171.5$ inflow $= 833.85$ gpm

$2.5 - 1.7 = 0.8$ m

$2.1 \times 3.4 \times 0.8 = 5.88\ m^3$

$\frac{5.88 \times 1000}{2 \times 60} = 41.7$ L/s

$\frac{935\ m^3/d \times 1000}{24 \times 60 \times 60} = 10.8$ L/s

$41.7 + 10.8 = 52.5$ L/s

A	Pump 1; 133 gpm (*8.4 l/sec*)
B	Pump 2; 133 gpm (*8.4 l/sec*)
C	Pump 1; 304 gpm (*19.2 l/sec*)
D	Pump 2; 304 gpm (*19.2 l/sec*)
E	Pump 1; 662 gpm (*41.8 l/sec*)
F	Pump 2; 662 gpm (*41.8 l/sec*)
G	Pump 1; 834 gpm (*52.6 l/sec*)
H	Pump 2; 834 gpm (*52.6 l/sec*)

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Proper answer: H

Points earned: 100

Scenario #3: Lift Station

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

Maximum point value for this question: **160**

4

If the city is able to reduce dry weather infiltration by 50%, what will be the average time between pump starts at the maximum pump rate, assuming the same pump control elevations and dry weather conditions?

A	11 minutes
B	12 minutes
C	13 minutes
D	27 minutes
(E)	28 minutes
F	29 minutes

Volume $7 \times 11 \times (8.1 - 5.8) \times 7.48 = 1324.7$ gal

$\frac{0.143 \times 1000000}{24 \times 60} = 99.3$ gpm $\quad \frac{99.3}{2} = 49.65$ gpm inflow

$\frac{1324.7}{49.65} = 26.68$ minutes to fill

$\frac{1324.7 \text{ gal}}{(1050 - 49.65)} = 1.32$ minutes to empty $\quad 26.68 + 1.32 = 28.00$ total

$2.5 - 1.8 = 0.7$ $\quad 2.1 \times 3.4 \times 0.7 = 5.0$ m³ volume

$\frac{541.3}{2} \times \frac{1000}{24 \times 60 \times 60} = 3.13$ L/sec inflow

$\frac{5.0 \times 1000}{3.13 \times 60} = 26.61$ to fill

$\frac{3.98 \times 1000}{60} = 66.3$ L/sec $\quad \frac{5000 \text{ L}}{66.3 - 3.13} \times \frac{1}{60} = 1.32$ min to empty

$26.61 + 1.32 = 27.93$

PM

$\frac{1324}{99} = 13.4$ min

$\frac{13.4}{1050 - 99} = 1.39$

14.8

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Proper answer: E
Points earned: 160

- Starting pumped flow settings (RAS flow, WAS flow)
- Starting aeration conditions (airflow, DO controllers, etc.)

In each question, the teams will receive 25 points per target achieved. Some questions have more targets than others. The table below summarizes the points for each question:

Question	Details	Points
1	High Effluent COD	50
2	High Effluent BOD_5 and NH_4	75
3	High Effluent TKN, Low MLSS and Limit on Energy Usage	100
4	Cold Wastewater Temperature, High Effluent BOD_5 and TN	50
5	High Effluent Total Phosphorus and Limit on Chemical Dosage	75
6	Cold Wastewater Temperature, High Effluent BOD_5 and NH_4	50
7	High Effluent Total Nitrogen and Limit on Energy Usage	50
8	Low SRT and MLSS	75
9	Energy and Chemical Cost Management	125
10	High-Strength Wastewater Treatment	50
11	SRT Control	75
12	Energy Management	75
13	Total Nitrogen Removal and Limit on Chemical Dosage	50
14	Clarifier Maintenance	50
15	Cold Wastewater Temperature, No DO Controller	50

Scoring

When the timer expires, the team's final score will be displayed. The final score will be the sum of all the points earned in all questions. **A perfect score is 1000 points.** There are no penalties for trying questions.

Scenario #2: Activated Sludge

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

4

Maximum point value for this question: **120**

After the diffuser upgrade, additional savings at the Gator WRP were achieved though replacing the current positive displacement air compressors with high efficiency blowers which will reduce blower power costs by 50% over the existing units. What will be the total yearly savings in power costs with all of the efforts at the Gator WRP?

$7000
-$2450
$4550

$4550
x0.5
$2275

$2450 diffuser
$2275 blower
$4725 total

$4725
x12
$56700

A	$29,550
B	$42,000
C	$48,950
(D)	$56,700
E	$58,950

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Proper answer: D

Points earned: 120

Scenario #2: Activated Sludge

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

2

Maximum point value for this question: **60**

What is the current F/M ratio of the Gator WRP? (Note: All 3 Aeration basins are in operation.)

A	0.15
B	0.19
(C)	0.26
D	0.39
E	0.52

$3 \times 0.5 \times 8.34 \times 1800 = 22518$ lbs MLSS

$3.5 \times 8.34 \times 200 = 5838$ lbs BOD

$\frac{5838}{22518} = 0.259$

$\frac{3 \times 1893 \times 1800}{1000} = 10222$ kg MLSS

$\frac{0.1533 \times 60 \times 60 \times 24 \times 200}{1000} = 2649$ kg BOD

$\frac{2649}{10222} = 0.259$

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Proper answer: C

Points earned: 60

Scenario #2: Activated Sludge

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

3

Maximum point value for this question: **90**

The Gator WRP invests $240,000 to convert to fine bubble aeration and reduces power usage by 35%. What is the payback period in years if the facility receives an energy savings grant from the power company for 50% of the investment?

$7000 × 0.35 = $2450/month

$240,000 × 0.50 = $120,000

120,000 / 2450 = 48.98 months

48.98 / 12 = 4.08 yrs

A	2 years
B	4 years
C	6 years
D	8 years
E	10 years

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Proper answer: B

Points earned: 90

Scenario #2: Activated Sludge

Use the scenario information for all questions and circle the correct answer for each.

You must show your work to receive full credit even if the answer is correct.

1

Maximum point value for this question: **50**

In previous testing, it was determined that 8 hours of treatment was needed for full treatment in aeration utilizing the daily average flow. What would be the contact time in the aeration basins with two basins operating?

$\frac{2 \times 0.5}{3.5} \times 24 = 6.85$

~~2×0.153~~

$\frac{2 \times 1893}{0.1533} \times \frac{1}{60} \times \frac{1}{60} = 6.86$

A	3.4 hours
B	4.8 hours
(C)	6.8 hours
D	7.8 hours
E	8.8 hours

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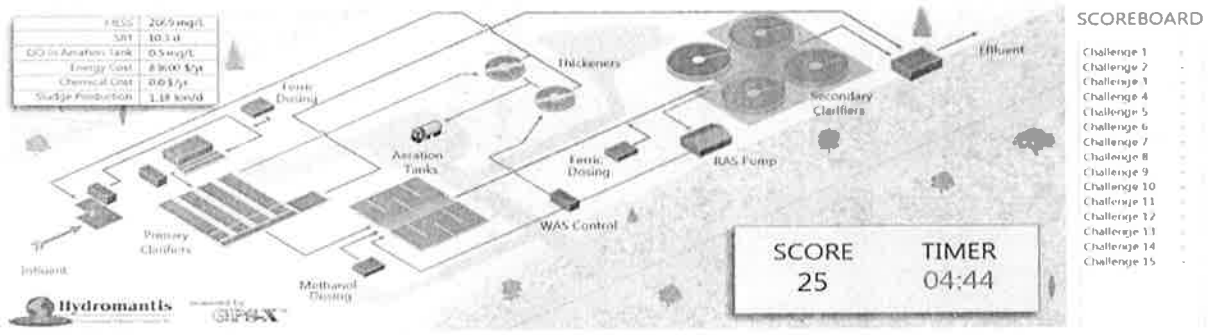
Proper answer: C

Points earned: 50

Operations Challenge Process Control Event – Simulator Question Background Information

The Plant

The wastewater treatment plant operations simulator (OpTool™) contains a mathematical model of the conventional wastewater treatment plant shown below:



The plant consists of:

- an influent pumping station
- rectangular primary clarifiers
- 2 plug-flow activated sludge aeration tanks
- 4 circular secondary clarifiers
- 2 chemical dosage points (for iron addition for chemical phosphorus precipitation)
- a recycled activated sludge (RAS) pumping station
- a waste activated sludge (WAS) pumping station
- 2 gravity sludge thickeners

The Challenge Questions

Teams will be presented with a total of **15 challenge questions**. Teams can answer the questions in any order they like, and can do any question over as many times as needed. Make sure to click on the red SUBMIT button to register your answer each time you complete the question.

The questions cover a wide range of operational situations, and require teams to make operational changes to the plant to achieve a given set of targets. The following aspects of the plant can change from question to question:

- Sizes of the aeration tanks
- Surface areas of the clarifiers
- Number of aeration tanks in service
- Number of secondary clarifiers in service
- Influent loading (flow, COD, BOD_5 ammonia, temperature, pH)