

**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 210 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

For grader's use	
Points	Proper answer
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

#	Question	Choices
1	The typical operation depth for digesters is approximately how many feet?	A 5 ft (1.5 m)
		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
		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
		B alkalinity
		C acidity
		D demand
4	How is phosphorus removed from wastewater?	A air stripping
		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
		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
		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	
7	Ultraviolet disinfection is becoming more popular because UV systems	A	Create disinfection byproducts
		B	Conserve energy
		C	Require no maintenance
		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
		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
		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
		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
		D	propane
12	Most of the major odorous gases contain which element?	A	iron (Fe)
		B	sulfur (S)
		C	magnesium (Mg)
		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

For grader's use	
Points	Proper answer
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

#	Question	Choices	
13	When it comes to hazards of a specific chemical, the best source of information is _____.	A	Your safety officer
		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)
		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
		B	ammonia
		C	hydrogen sulfide
		D	methane
16	Nitrogen and _____ are essential nutrients for microbial growth.	A	chlorine
		B	phosphorus
		C	sulfur
		D	boron
17	When sludge does not settle properly, the condition is typically referred to as _____.	A	denitrification
		B	nitrification
		C	bulking
		D	blowdown
18	A limiting factor for digester loading is _____.	A	sludge color
		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
		D	calcium hydroxide
20	Most gas piping systems are rated for _____ service.	A	700 kPa (100 psi)
		B	1050 kPa (150 psi)
		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
		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
		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
		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)
		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	
25	The destabilization of sludge particles by decreasing the repulsive forces between particles is called _____.	A	equalization
		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
		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
		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
		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
		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
		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

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

For grader's use	
Points (25)	Proper answer

Extended Multiple Choice

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

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 contactors
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 _____.	
7	Potassium permanganate is typically used for _____ in wastewater treatment.	
8	Which treatment unit is dependent on suspended bacteria for efficiency?	
9	A "rotten egg" odor near a trickling filter generally indicates _____.	
10	The destruction of the larger portion of microorganisms with the probability that all pathogens are killed is called _____.	

For grader's use	
Points (50)	Proper answer

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)	A 195000 gal (740000 liters)
		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?	A 28 mg/l
		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?	A 3596 lbs/day (1631 kg/day)
		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 _____.	A 0.72 mgd
		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?	A 500 mg/L
		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
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?	A 1581 lb (717 kg)
		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 (m ³) of sludge liquid are in the tank?	A 587,000 gals (2220 m ³)
		B 713,000 gal (2700 m ³)
		C 840,000 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.	A 25 HP (15 kW)
		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?	A 512 lbs/day (232 kg/day)
		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?	A 196 gal (742 liters)
		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 m³/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 m²/m³) of media with a design BOD loading of 150 lbs/day/1000 cu ft (2.4 kg/m³/d) while the high rate filter's plastic media is 48 sq ft/cu ft (157.5 m²/m³) of media with a design BOD loading of 25 lbs/day/1000 cu ft (0.4 kg/m³/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: Tricking 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.

	<p>Maximum point value for this question: 90</p> <p>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?</p>	
A	47.8 lbs BOD/1000 cu ft (0.77 kg/m ³)	<p>For grader's use only</p> <p>Proper answer _____</p> <p>Points earned _____</p>
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)	

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.

	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)		For grader's use only	
		B	1911 gpd/sq ft (77.9 m ³ /m ² /d)			Proper answer <u> </u>
		C	4770 gpd/sq ft (194.3 m ³ /m ² /d)			Points earned <u> </u>
		D	5732 gpd/sq ft (233.5 m ³ /m ² /d)			

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.

	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		

For grader's use only		
	Proper answer	_____
	Points earned	_____

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.

	Maximum point value for this question: 210				
A	0.08 RPM	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?			
B	0.25 RPM				
C	0.46 RPM				
D	0.63 RPM				
Hint SK = mm/pass = (flow in m ³ /m ² /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	_____	_____	_____	_____	_____
Points earned	_____	_____	_____	_____	_____

Operator Bertha was just hired to maintain the excellent performance of the Gator Water Reclamation Facility while reducing operating costs of the facility as a major industry had just closed and budgets were tight. The Gator WRC is a standard plug flow activated sludge plant with coarse bubble aeration, positive displacement blowers and rectangular final clarifiers. The facility has no primary clarifiers.

Facility Design & Data	
Daily Average Flow after Gator Shoe Plant closed.	3.5 MGD (0.1533 cubic meters/second)
Current Maximum Daily Flow	5 MGD (0.219 cubic meters/second)
Three Activated Sludge Basins	500,000 Gallons (1,893 cubic meters) each
MLSS	2500 mg/l
MLVSS	1800 mg/l
Total monthly aeration power cost	\$7,000
Influent Data	200 mg/l BOD ₅ & TSS
Effluent Data	20 mg/l BOD ₅ & 30 mg/l TSS

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.

	Maximum point value for this question: 50				
A	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?	3.4 hours			
B		4.8 hours			
C		6.8 hours			
D		7.8 hours			
E		8.8 hours			

For grader's use only		
	Proper answer	_____
	Points earned	_____

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.

Maximum point value for this question: 60		A	0.15	
What is the current F/M ratio of the Gator WRP? (Note: All 3 Aeration basins are in operation.)		B	0.19	
		C	0.26	
		D	0.39	
		E	0.52	
	2			

For grader's use only		
	Proper answer _____	
	Points earned _____	

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.

	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?	A	2 years		For grader's use only Proper answer _____ Points earned _____
		B	4 years		
		C	6 years		
		D	8 years		
		E	10 years		

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.

	Maximum point value for this question: 120				
A				\$29,550	
B				\$42,000	
C				\$48,950	
D				\$56,700	
E				\$58,950	

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?

For grader's use only		
	Proper answer _____	
	Points earned _____	

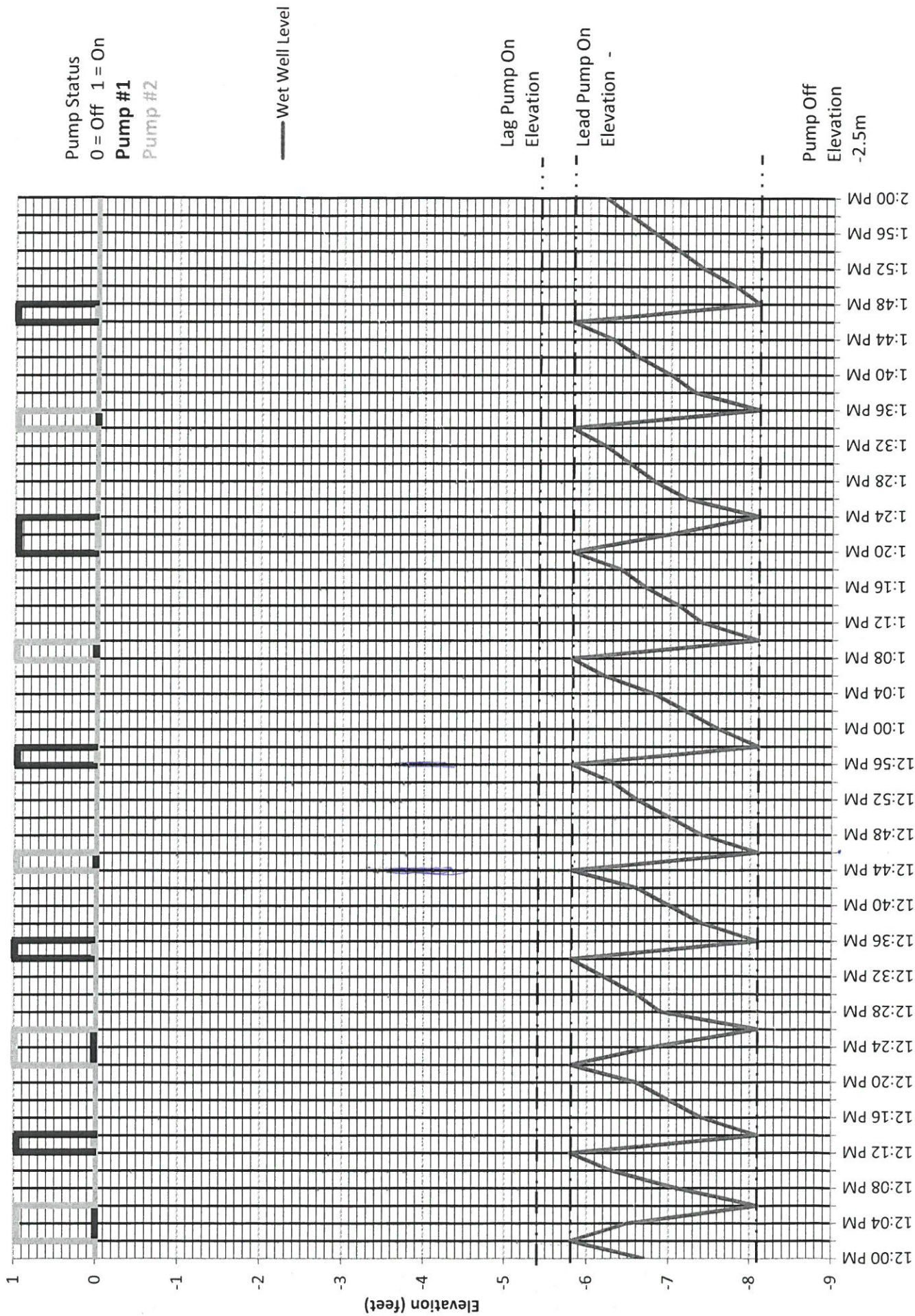
Below are the characteristics of the 24th Street Pumping Station. This is a duplex pumping station where the pumps alternate between lead and lag duty. Please use the below characteristics and the attached SCADA Graph to answer any questions. All elevations are in reference of mean sea level (i.e. 0 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 (28.04 m)

Scenario #3 Lift Station Data



32

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: 60	A 1271 gal (4810 liters)
What is the maximum volume of the wet well only not including any potential storage in the gravity collection system?	B 3513 gal (13300 liters)
	C 6508 gal (24600 liters)
	D 9503 gal (35970 liters)

For grader's use only
Proper answer _____
Points earned _____

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.

	A	Yes	
	B	No	
	C	Sometimes	
<p>Maximum point value for this question: 50</p> <p>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)</p>			

For grader's use only		
Proper answer	_____	_____
Points earned	_____	_____

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: 100		
3	Utilizing the SCADA chart which pump is operating between 12:44 PM and 12:56 PM? What is the calculated pump discharge assuming inflow is average daily flow?	<p>A Pump 1; 133 gpm (8.4 l/sec)</p> <p>B Pump 2; 133 gpm (8.4 l/sec)</p> <p>C Pump 1; 304 gpm (19.2 l/sec)</p> <p>D Pump 2; 304 gpm (19.2 l/sec)</p> <p>E Pump 1; 662 gpm (41.8 l/sec)</p> <p>F Pump 2; 662 gpm (41.8 l/sec)</p> <p>G Pump 1; 834 gpm (52.5 l/sec)</p> <p>H Pump 2; 834 gpm (52.5 l/sec)</p>	<p>For grader's use only</p> <p>Proper answer _____</p> <p>Points earned _____</p>

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.

4	<p>Maximum point value for this question: 160</p> <p>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?</p>	<p>A 11 minutes</p> <p>B 12 minutes</p> <p>C 13 minutes</p> <p>D 27 minutes</p> <p>E 28 minutes</p> <p>F 29 minutes</p>
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For grader's use only	Proper answer _____
	Points earned _____