Operations Challenge Process Control Event – Simulator Question Background Information

The 2022 Operations Challenge simulator contains 2 plant layouts:

- Layout #1 – Main plant
- Layout #2 – Biosolids Treatment Plant

There are 6 challenge questions from layout 1 and 2 challenge questions from layout 2. The simulator interface will switch to the appropriate layout when a challenge question is selected.
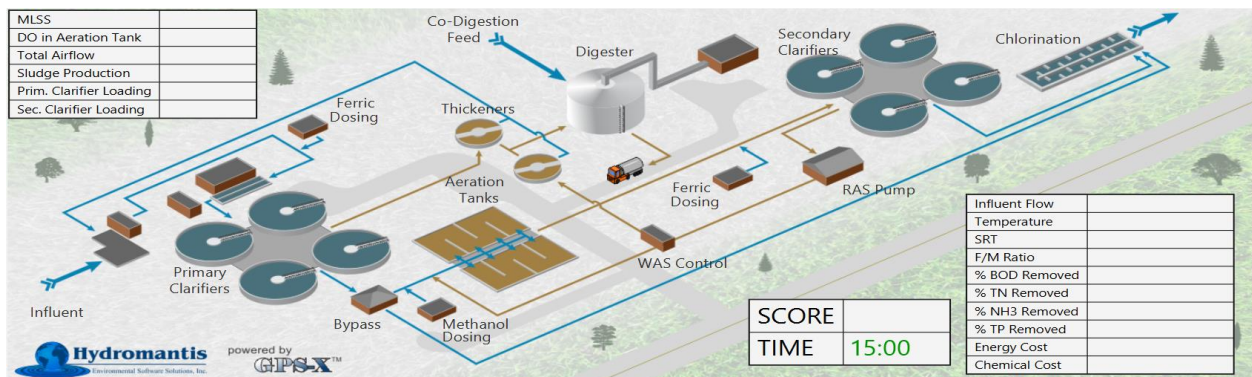

Layout #1 – Main Plant

Layout #1 is the wastewater treatment plant operations simulator (OpTool), where it contains a mathematical model of the conventional wastewater treatment plant shown below:

The plant consists of:

- an influent pumping station

- 4 circular primary clarifiers
- 2 parallel plug-flow activated sludge aeration tanks (4 zones in series)
- 4 circular secondary clarifiers
- 2 chemical dosage points (for iron addition for chemical phosphorus precipitation)
- a methanol dosage point (for denitrification)
- a NaOH (sodium hydroxide) dosage point
- a recycled activated sludge (RAS) pumping station
- a waste activated sludge (WAS) pumping station
- 2 gravity sludge thickeners
- an anaerobic digester (with co-digestion feed point)
- a chlorine disinfection tank

The Challenge Questions for layout #1

Teams will be presented with a total of 6 challenge questions in plant #1. 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. Clicking on the SUBMIT button erases the previous answer for that question, so if you do a question several times, it will only remember the last answer that you submitted.

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. See special notes about Questions 6 at the end of the document.

Please note that Questions 6 involves running a 5-day dynamic simulation, which takes approximately 2 minutes to complete. Please make sure to leave enough time to complete the simulation before clicking on the SUBMIT button.

The following aspects of the plant can change from question to question:

- Sizes of the aeration tanks
- Surface areas of the clarifiers
- Number of primary clarifiers in service
- Number of aeration tanks in service
- Number of secondary clarifiers in service
- Influent loading (flow, COD, BOD_5, ammonia, temperature, pH)
- Food waste loading (flow, TSS, ammonia, temperature, pH)
- Starting pumped flow settings (RAS flow, WAS flow)
- Starting aeration conditions (airflow, DO controllers, etc.)
- Starting digester condition (temperature)
- Starting chemical addition settings (methanol, ferric, chlorine, sodium hydroxide, sulfur dioxide)

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	Maximum Possible Points
1	High Strength Wastewater	100
2	SRT Management	50
3	Cold Weather Operation	75
4	Biological Phosphorus Removal	75
5	Chemical Cost Management	125
6	Dynamic Wet Weather	225

Notes for All Questions

Please note that all Food-to-Microorganism (F/M) ratio calculations are calculated as $lbBOD_5/lbVSS/d$ (or in SI units, $gBOD_5/gVSS/d$).

The input settings are bounded. If you set the value outside of the respective input range, the simulator will set it back to the limit.

Special Notes for Question 6: Dynamic Wet Weather

In Question 6, you will run a 5-day dynamic simulation where the influent flow changes during the 5-days, as shown in the graph below:
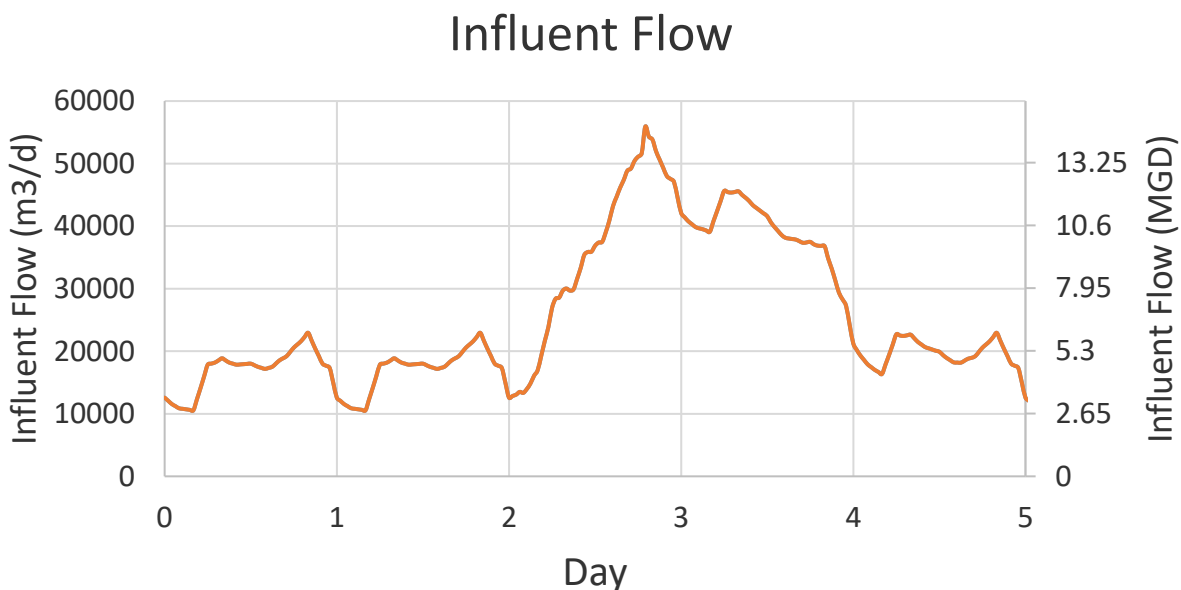
Note that a large wet weather event happens at the end of the 3rd day. The base wastewater influent concentrations are kept constant but are diluted with the stormwater flow. **In this question, one secondary clarifier is out of service for maintenance purpose. The blower capacity is 2,450 ft³/min (100,000 m³/d).**

During the 5-day simulation, a 24-hour composite sample (one sample taken each hour) will be reported at the end of each day in the table in the lower-right corner of the screen. The red or green background will indicate whether the sample meets the specified target:

In order to score points, **all 5 composite samples must meet the target** (for one particular parameter, such as TSS). If the target is met for all 5 days, **75 points** are scored. For example, all 5 TSS composite samples must be below 20 mg/L in the example above, and since the samples on days 3,4 and 5 do not meet the target, zero points would be score for TSS.

The three different parameters (in the above example, TSS, BOD5 and ammonia) are scored independently, so it is possible to get 0, 75, 150 or 225 points on this question, depending on the operational choices made.

Additional Data for Question 6:

Parameter	Value
Influent Concentrations:	
COD	400 mg/L
TKN	40 mg/L
Ammonia	28 mg/L
Total Phosphorus	12 mg/L
Soluble Ortho-P	8 mg/L
pH	7 mg/L
Influent Flow	Daily diurnal pattern average = 4.5MGD (17,000 m³/d)

	During storm event, clean water is mixed with influent flow, peaking at ~9.1 MGD (34,320 m³/d) additional flow (see graph above).
Influent Temperature	68 °F 20 °C
Aeration Tank Volume	2 tanks @ 0.53 MGal (2000 m³) each
Clarifier Surface Area Primary Clarifiers Secondary Clarifiers	*Some units may not be available* 4 clarifiers @ 3,875 ft² (360 m²) each 4 clarifiers @ 4,090 ft² (380 m²) each

Optimal Process Parameter Ranges	
Aerobic Solids Retention Time (SRT)	3 – 10 days
Secondary Clarifier Solids Loading Rate (SLR)	<2.0 lb/ft2/hr <10.0 kg/m2/hr

Layout #2 – Biosolids Treatment Plant

The new layout #2 focuses on the biosolids treatment operations, the simulator contains a mathematical model of the conventional anaerobic digestion plant shown below:
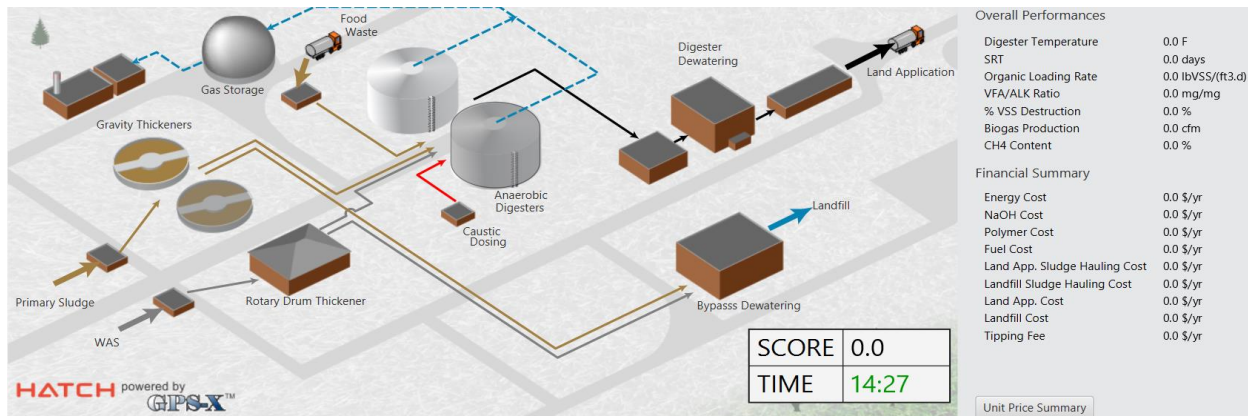
The biosolids plant consists of:

- an influent pumping station for primary sludge
- an influent pumping station for WAS
- an influent pumping station for food waste
- 2 gravity thickeners
- a rotary drum thickener
- 2 anaerobic digesters
- a NaOH (sodium hydroxide) dosage point
- a dewatering system for digested sludge

- a dewatering system for bypassed sludge
- Land application
- Landfill

The Challenge Questions for Layout #2

Teams will be presented with a total of 2 challenge questions in plant #2. 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. Clicking on the SUBMIT button erases the previous answer for that question, so if you do a question several times, it will only remember the last answer that you submitted.

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 anaerobic digesters
- Number of anaerobic digesters in service
- Surface areas of the thickeners
- Number of gravity thickeners in service
- Bypass percentage for thickened sludges
- Influent sludge loading (flow, TSS, ammonia, temperature, pH)
- Food waste loading (flow, TSS, ammonia, temperature, pH)
- Starting digester condition (temperature)
- Starting chemical addition settings (sodium hydroxide)

In each question, the teams will receive **50 points** per target achieved. Some questions have more targets than others. The table below summarizes the points for each question:

#	Question	Maximum Possible Points
7	Primary Sludge Digestion	150
8	Anaerobic Co-Digestion	200

Final 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.

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