

Illinois Environmental Protection Agency
Division of Water Pollution Control
Class 1 Study Guide
Wastewater Operator Certification

The purpose of this study guide is to explain the testing process and to help you prepare for the Class 1 wastewater operators certification examination.

If this is your first exam attempt, a short history of the current exam development should be of interest. The exam questions were developed by experts in the field of wastewater. Each question has been validated through a process of panel review. The panel is comprised of 8 experts who have worked for many years in the wastewater field. Every question with each of the four answer selections has been examined for content, readability, accuracy, and relation to the Task Analysis.

The process of validation has taken several years. It is an on-going process with new questions being developed and reviewed each year. You might say the job is never finished since existing validated questions must also prove reliable; that is they test what they are supposed to test. Reliability can only be established from statistical evidence, which takes a minimum question repetition of 100 times. If statistics show a question to be unreliable, it is removed from the question bank. Unreliable questions are sent back to the review panel for restructuring.

Each exam question is related back to one of twenty-eight subject categories; these are:

- | | |
|-------------------------------|-----------------------------|
| 1. Activated Sludge | 15. Math |
| 2. Chemical Addition | 16. Motors |
| 3. Collection Systems | 17. Preliminary Treatment |
| 4. Digesters | 18. Primary Treatment |
| 5. Disinfection | 19. Pumps and Pumping |
| 6. Electrical | 20. RBC's |
| 7. Flow Measurement | 21. Recordkeeping |
| 8. General Information | 22. Rules and Regulations |
| 9. Imhoff Tanks | 23. Safety and Health |
| 10. Intermittent Sand Filters | 24. Secondary Sedimentation |
| 11. Laboratory | 25. Sludge Drying Beds |
| 12. Lagoons | 26. Sludge Handling |
| 13. Maintenance | 27. Tertiary Treatment |
| 14. Management | 28. Trickling Filters |

Each Class 1 exam version has 100 multiple choice questions taken from any combination of the twenty-eight categories.

When you take the Class 1 exam, you are given one exam booklet containing questions, formulas and conversion factors, one answer sheet, two sheets of scratch paper and two pencils. The only item you may bring to the exam site is your calculator which must be non-programmable and

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incapable of storing alpha-numeric data. You are allowed a maximum of three hours to complete the exam. A copy of the conversion factors and formulas are provided at the back of this study guide. If you familiarize yourself with the format, it should cut down your referencing time during the examination.

Usually within two weeks of exam completion, your results are sent to your home. Whether or not you passed the exam, you receive a detailed breakdown of your performance as shown below:

| CATEGORY | NUMBER OF QUESTIONS | NUMBER CORRECT | NUMBER INCORRECT | % CORRECT IN CATEGORY |
|--------------------|---------------------|----------------|------------------|-----------------------|
| LAGOONS | 4 | 2 | 2 | 50% |
| RBC'S | 2 | 1 | 1 | 50% |
| SLUDGE HANDLING | 2 | 1 | 1 | 50% |
| LABORATORY | 6 | 3 | 3 | 50% |
| MATH | 10 | 6 | 4 | 60% |
| DIGESTERS | 14 | 9 | 5 | 64% |
| FLOW MEASUREMENT | 3 | 2 | 1 | 67% |
| TRICKLING FILTERS | 7 | 5 | 2 | 71% |
| ACTIVATED SLUDGE | 20 | 15 | 5 | 75% |
| DISINFECTION | 5 | 4 | 1 | 80% |
| COLLECTION SYSTEMS | 10 | 9 | 1 | 90% |
| PRIMARY TREATMENT | 5 | 5 | 0 | 100% |
| SAFETY | 4 | 4 | 0 | 100% |
| INTERMITTENT S.F. | 2 | 2 | 0 | 100% |
| SLUDGE DRYING BEDS | 1 | 1 | 0 | 100% |
| MOTORS | 2 | 2 | 0 | 100% |
| ELECTRICAL | 3 | 3 | 0 | 100% |
| ----- | | | | |
| TOTAL | 100 | 74 | 26 | 74% |

Should you fail to achieve a score of 70%, you can use these results to determine the areas to study. In the above example, the examinee scored the lowest percent correct (50%) on Lagoons, RBC's, Sludge Handling and Laboratory but lost the most points on Digesters (5 points), Activated Sludge (5 points) and Math (4 points). It would be wise to review all seven subject categories. Notice how the category list progresses from lowest percent correct (Lagoons 50%) to highest percent correct (Electrical 100%). This category list would appear in different orders for various examinees, depending on each examinee's area(s) of weakness.

If you score less than 70%, you may reschedule the Class 1 exam without submitting another application by returning the exam scheduling form provided with your results. When you do retest, the number of questions per category or the categories themselves may differ on the exam you are given. If you find a need for additional technical information, there is a list of suggested reading on page 11 of this study guide.

The following is a list of the main subject areas that may be covered on the Class 1 examination. The questions are provided to show you the type of questions that one might expect to see on the examination; however, these exact questions do not appear on the examination.

I. General Information

A. Characteristics of wastewater

B. Activated sludge terminology

Example Question:

The Hatfield Process is the same as the Kraus Process with the following exception:

- a) 10 to 15% of the return activated sludge stream is reaerated in the presence of anaerobic digester supernatant and digested sludge
- b) 65 to 70% of the return activated sludge stream is reaerated in the presence of anaerobic digester supernatant and digested sludge
- c) 100% of the return activated sludge stream is reaerated in the presence of anaerobic digester supernatant and digested sludge
- d) the Hatfield Process and the Kraus Process are not similar enough to compare with only one exception

II. Collection Systems

A. Routine operation and maintenance of collection system components

B. Sewer installation inspections

C. Troubleshooting collection systems

Example Question:

Below is a set of data or events, reflecting a problem at a pumping station. Wet well inlet receives dry weather flow; lead pump cycles on at proper wet well level; lag pump cycles on at proper wet well level; wet well level drops after lag pump cycles on; discharge pressure rises after lag pump cycles on. Study the data carefully. Which one of the following is the most probable cause of the problem?

- a) lead pump's main fuse is blown
- b) clogged suction line
- c) lead and lag pumps do not alternate correctly
- d) none of the above

III. Pumps and Pumping

A. Types of pumps and motors and their application

B. Operation and maintenance

1. Pumps

2. Motors

3. Pump and motor controls

4. Electrical

Example Question:

The discharge piping of a 3 phase induction motor driven centrifugal pump is rerouted such that the TDH against which the pump is pumping is reduced by 50%. This will cause:

- a) the motor to draw more amperage
- b) motor to run cooler
- c) motor to run faster
- d) the motor to draw less amperage

IV. Flow Measurement

A. Instruments

B. Process controls

Example Question:

A magnetic flow meter is a:

- a) displacement meter
- b) differential head meter
- c) velocity head meter
- d) none of the above

V. Preliminary Treatment

A. Theory of preliminary treatment

B. Operation and maintenance

- 1. Bar screens
- 2. Barminutors
- 3. Comminutors
- 4. Grit chambers

Example Question:

Pre-chlorination is not used for:

- a) reduction of BOD
- b) aiding in sedimentation
- c) protection of plant structures
- d) disinfection

VI. Primary Treatment

A. Theory of primary treatment

B. Operation and maintenance

1. Primary clarifiers

2. Imhoff tanks

Example Question:

Which of the following is not a typical percentage for primary clarifier removal efficiency?

- a) bacteria -- 25% to 75%
- b) settleable solids -- 90% to 95%
- c) Total solids -- 60% to 75%
- d) BOD -- 25% to 35%

VII. Secondary Treatment

A. Theory of secondary treatment

B. Operation and Maintenance

1. Lagoons

2. Slow sand filters

3. RBC's

4. Trickling filters

5. Activated sludge units

6. Secondary Sedimentation

Example Question:

Given the following data, describe the action necessary to make the F/M ratio 0.3 assuming 75% volatile solids in the mixed liquor.

Data: Daily flow = 2.0 MGD, Average primary effluent = 120 mg/l, Aeration tank capacity = 500,000 gallons, SVI = 80, RAS concentration = 9,000 mg/l, MLSS = 3,000 mg/l.

- a) increase sludge wasting
- b) increase return sludge rate
- c) decrease sludge wasting
- d) no action is necessary

VIII. Sludge Handling

A. Theory of sludge handling

B. Operation and maintenance

- 1. Anaerobic digesters
- 2. Aerobic digesters
- 3. Sludge drying equipment
 - a. Coil or cloth filters
 - b. Sludge drying beds
 - c. Filter presses
 - d. Sludge lagoons
- 4. Sludge thickening equipment
 - a. Flootation devices
 - b. Gravity thickening devices
 - c. Chemical addition and/or conditioning
- 5. Sludge disposal
 - a. Land application
 - b. Landfill disposal
 - c. Incineration

Example Question:

The maximum temperature change an anaerobic digester should undergo per 24-hour period should be:

- a) 0.5 degree F
- b) 2 degrees F
- c) 5 degrees F
- d) none of the above

IX. Tertiary Treatment

A. Theory of tertiary treatment

B. Operation and maintenance

- 1. Polishing ponds
- 2. Intermittent sand filters
- 3. Rapid sand filters
- 4. Microstrainers

Example Question:

Anaerobic conditions in an intermittent sand filter:

- a) are normal
- b) will have little effect on effluent quality
- c) will have a significant effect on effluent quality
- d) can be controlled by occasionally flooding the filter

X. Disinfection

A. Theory of disinfection

B. Operation and maintenance

- 1. Chlorination systems
- 2. Other disinfection systems

Example Question:

Which of the following is the most potent disinfecting agent?

- a) chlorine
- b) hypochlorous acid
- c) chloramines
- d) all of the above disinfect equally

XI. Laboratory

A. Process control testing

- | | | |
|--------|----------------------|----------------|
| 1. BOD | 5. Settleable solids | 8. Alkalinity |
| 2. TSS | 6. Volatile solids | 9. F/M ratio |
| 3. COD | 7. Volatile acids | 10. Sludge age |
| 4. SVI | | |

B. NPDES testing

- | | |
|----------------------|-----------------|
| 1. pH | 5. Ammonia |
| 2. BOD | 6. DO |
| 3. TSS | 7. Heavy metals |
| 4. Chlorine residual | |

Example Question:

If it takes 15 ml of 0.10 N H_2SO_4 to run a total alkalinity test using 100 ml sample, the total alkalinity, as $CaCO_3$, is:

- a) 7,500 mg/l
- b) 750 mg/l
- c) 75 mg/l
- d) 7.5 mg/l

XII. Safety and Health

- A. Clothing and apparel
- B. Machinery
- C. Chemical handling
- D. Laboratory

E. Collection systems

Example Question:

Of the following items, what is the first thing the operator should do before he places his hand inside a pump volute to clear an obstruction?

- a) make sure he has the proper tools to do the job
- b) trip and lock out the circuit breaker
- c) flush and drain the pump
- d) put on rubber gloves

XIII. Record Keeping

A. Plant operations

B. Laboratory data

C. Financial data

D. Maintenance data

E. Accident data

Example Question:

According to NPDES permit requirements, which of the following records are required to be kept?

- a) personnel records
- b) laboratory quality assurance records
- c) purchase orders
- d) annual operation and maintenance reports

XIV. Rules and Regulations

A. 35 Ill. Adm. Code, Subtitle C: Water Pollution

B. 35 Ill. Adm. Code Part 391 (Design Criteria For Sludge Application On Land)

C. NPDES

D. Local ordinances

Example Question:

A treatment facility is meeting effluent limits, however, it may be contributing to a violation of:

- a) nothing
- b) a BOD water quality standard
- c) a DO water quality standard
- d) a pH water quality standard

XV. Mathematics

A. General math

B. Process control math

C. Laboratory math

Example Question:

Given the following data, calculate the influent flow rate.

Data: MLSS = 2,800 mg/l, MLVSS = 2,000 mg/l, Return sludge concentration = 9,200 mg/l, RAS flow rate 3.0 MGD.

- a) 5.8 MGD
- b) 6.9 MGD
- c) 7.6 MGD
- d) none of the above

LIST OF SUGGESTED READING

1. MOP 1 Safety and Health in Wastewater Systems
2. MOP 5 Aeration in Wastewater Treatment
3. MOP 11 Operation of Wastewater Treatment Plants
4. MOP 16 Anaerobic Sludge Digestion
5. Standard Methods for the Examination of Water and Wastewater - Latest Edition
6. MOPOM 7 Operation of Extended Aeration Package Plants
7. Wastewater Biology: The Microlife
8. MOP OM-8 Operation and Maintenance of Sludge Dewatering Systems

The preceding eight publications are available through:

Water Environment Federation
Publications Order Department
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206
Website: www.wef.org

9. Manual of Wastewater Treatment

Available through:

Texas Water Utilities Association
1106 Clayton Lane, Suite 101-E
Austin, TX 78723-1033

10. Operation of Wastewater Treatment Plants, a Field Study Training Program
 - a. Volume I
 - b. Volume II
11. Advanced Waste Treatment, A Field Study Training Program
12. Operation and Maintenance of Wastewater Collection Systems, a Field Study Training Program

The correspondence courses and/or texts for items 10, 11 and 12 are available through:

Kenneth Kerri
Department of Civil Engineering
California State Univ., Sacramento
6000 J Street
Sacramento, CA 95819
(916) 278-6142
Website: www.owp.csus.edu

and

Correspondence Course Coordinator
Environmental Resources Training Center
Campus Box 1075 - Southern Illinois Univ.
Edwardsville, IL 62026-1075
(618) 650-2030

13. Aerobic Biological Wastewater Treatment Facilities, USEPA 430/9-77-006, SN/055-001-01071-1
14. Anaerobic Sludge Digestion, USEPA 430/9-76-001

Items 13 and 14 are available through:

ORD Publications
P.O. Box 19962
Cincinnati, OH 45219
(513) 569-7562

or

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

15. Math Review for Wastewater Certification
16. Stabilization Pond Filtration
17. Guide to Microscopic Evaluation for Sewage Treatment Operations

Items 15, 16 and 17 are available through:

Environmental Resources Training Center
Campus Box 1075 - Southern Illinois Univ.
Edwardsville, IL 62026-1075
(618) 650-2030

18. WPCF/ABC Studyguide for Wastewater Treatment and Collection System Personnel (Order No. E0-376PC) by the Water Environment Federation and the Association of Boards of Certification

Available through:

Water Environment Federation
Publications Order Department
601 Wythe Street
Alexandria, VA 22314-1994
(800) 666-0206
Website: www.wef.org

19. Design Criteria for Sludge Application of Land (35 Ill. Adm.Code Part 391)

Available through:

Illinois Environmental Protection Agency
DWPC/Permit Section/Watershed Unit #15
P.O. Box 19276
Springfield, IL 62794-9276
(217) 782-1696

FORMULA SHEETS

CONVERSION FACTORS

$$\text{Pi } (\pi) = 3.14$$

$$1 \text{ gallon of water} = 8.34 \text{ pounds}$$

$$1 \text{ gallon of water} = 4 \text{ quarts} = 8 \text{ pints} = 3.785 \text{ liters}$$

$$1 \text{ Population Equivalent (PE)} = 0.17 \text{ pounds BOD/capita/day}$$

$$\text{"} = 0.20 \text{ pounds SS/capita/day}$$

$$\text{"} = 100 \text{ gallons water/capita/day}$$

$$1 \text{ day} = 24 \text{ hours} = 1440 \text{ minutes}$$

$$1 \text{ square foot (ft}^2\text{)} = 144 \text{ square inches (in}^2\text{)}$$

$$1 \text{ square yard (yd}^2\text{)} = 9 \text{ square feet (ft}^2\text{)}$$

$$1 \text{ cubic foot (ft}^3\text{)} = 7.5 \text{ gallons} = 1728 \text{ cubic inches (in}^3\text{)}$$

$$1 \text{ cubic yard (yd}^3\text{)} = 27 \text{ cubic feet (ft}^3\text{)}$$

$$1 \text{ acre} = 43560 \text{ square feet (ft}^2\text{)}$$

$$1 \text{ horsepower (HP)} = 33,000 \text{ foot-pounds/minute (ft-lb/min)} = 746 \text{ watts} = 0.746 \text{ kilowatts (kw)}$$

$$1 \text{ foot of water} = 0.433 \text{ pounds/square inch (psi)}$$

$$1 \text{ pound/square inch (psi)} = 2.31 \text{ feet of water}$$

VOLUMES, AREAS, & PERIMETERS

GIVEN: V = Volume, L = Length, H = Height, W = Width, r = radius, d = diameter, π = Pi,
b = base, P = Perimeter, C = Circumference

VOLUMES

$$\text{Rectangular Solid: } V = L \times W \times H$$

$$\text{Cylinder: } V = \pi r^2 H = \frac{\pi d^2 H}{4} = 0.785 d^2 H$$

$$\text{Sphere: } V = \frac{4}{3} \pi r^3$$

$$\text{Cone: } V = \frac{1}{3} \pi r^2 H$$

$$\text{Pyramid: } V = \frac{1}{3} L \times W \times H$$

PERIMETER

$$\text{Polygon: } P = L_1 + L_2 + L_3 + \dots + L_n$$

$$\text{Circle: } C = \pi d$$

AREA

$$\text{Rectangle: } A = L \times W$$

$$\text{Triangle: } A = \frac{1}{2} b \times H$$

$$\text{Circle: } A = \pi r^2 = \frac{\pi d^2}{4} = 0.785 d^2$$

$$\text{Trapezoid: } A = \frac{1}{2} (b_1 + b_2) H$$

PROCESS FORMULAS

TEMPERATURE

$$^{\circ}\text{F} = 9/5 ^{\circ}\text{C} + 32$$

$$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{K} = ^{\circ}\text{C} + 273$$

FLOW MEASUREMENT

$$90^\circ \text{ V-notch weir: } Q = 2.5H^{2.5}$$

$$\text{Sharp-crested weir: } Q = 3.33LH^{1.5}$$

$$\text{Cippolletti weir: } Q = 3.367LH^{1.5}$$

$$\text{Proportional weir: } Q = 7.57mH$$

$$\text{Parshall flume: } Q = 4WH^{1.52}W^{0.026}$$

ELECTRICITY

$$\text{Power} = \text{Current} \times \text{Voltage}$$

$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

$$\text{Average Current} = \frac{\text{Line 1 Current} + \text{Line 2 Current} + \text{Line 3 Current}}{3}$$

$$\text{Current Imbalance} = \frac{\text{Average Current} - \text{Maximum Deviation}}{\text{Average Current}} \times 100$$

MISCELLANEOUS

$$\text{Efficiency} = \frac{\text{In} - \text{Out}}{\text{In}} \times 100\%$$

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow Rate}}$$

$$\text{Application Rate} = \text{Concentration} \times \text{Flow} \times \text{Conversion Factor}$$

$$\text{Loading Rate} = \frac{\text{Concentration} \times \text{Flow} \times \text{Conversion Factor}}{\text{Area}}$$

LABORATORY

$$\text{BOD}_5 \text{ (mg/l)} = (\text{Initial DO} - \text{Final DO}) \times \frac{\text{Bottle Volume}}{\text{Sample Volume}}$$

$$\text{SS Concentration (mg/l)} = \frac{\text{Weight of Solids (g)}}{\text{Amount of Sample (ml)}} \times \text{Conversion Factor(s)}$$

$$\% \text{ Capture} = \frac{\text{Sludge SS} - \text{RAS SS}}{\text{Wet Sludge}} \times 100$$

$$\% \text{ Solids} = \frac{\text{Dry Sample}}{\text{Wet Sample}} \times 100$$

$$\% \text{ Moisture} = \frac{\text{Wet Sludge} - \text{Dry Solids}}{\text{Wet Sludge}} \times 100$$

$$\% \text{ Volatile Solids} = \frac{\text{Dry Sample} - \text{Ash}}{\text{Dry Sample}} \times 100$$

$$\% \text{ Reduction in Volatile Matter} = \frac{\text{In} - \text{Out}}{\text{In} - (\text{In} \times \text{Out})} \times 100$$

CLARIFIER

$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow Rate}}$$

$$\text{Weir Overflow Rate} = \frac{\text{Flow}}{\text{Length}}$$

$$\text{Surface Settling Rate} = \frac{\text{Flow}}{\text{Surface Area}}$$

PROCESS CONTROL

$$F/M = \frac{\text{lbs of BOD}}{\text{lbs of MLSS}}$$

$$(Q + RQ) \text{ MLSS} = RQ \times \text{RAS}$$

$$\text{MLSS (mg/l)} = \frac{\text{MLSS (lbs)}}{\text{Volume} \times \text{Conversion Factor(s)}}$$

$$\text{SDI} = \frac{\text{MLSS (mg/l)}}{\text{Settled Sludge Volume (ml) (30 minutes)} \times 10} \text{ or } \frac{100}{\text{SVI}}$$

$$\text{SVI} = \frac{\text{Settled Sludge Volume (ml) (30 minutes)} \times 1000}{\text{MLSS (mg/l)}}$$

$$\text{Gould's Sludge Age} = \frac{\text{lbs of MLSS [Aeration Tank(s)]}}{\text{lbs of TSS (Influent)}}$$

$$\text{MCRT} = \frac{\text{lbs of MLSS (Aeration Tank)} + \text{lbs of Solids (Clarifier)}}{[(\text{RAS(mg/l)} \times \text{WAS Flow}) + (\text{Effluent SS(mg/l)} \times \text{Flow})] \times \text{Conversion Factor}}$$

$$\text{Mixed Concentration} = \frac{(\text{Upstream Flow} \times \text{Upstream Concentration}) + (\text{Effluent Flow} \times \text{Effluent Concentration})}{\text{Downstream Flow}}$$

SLUDGE LAND APPLICATION

$$\text{lb/ton} = \text{mg/l} \times 0.002$$

$$1 \text{ mg/kg} = 0.002 \text{ lbs/ton}$$

$$\text{gal/acre} = \frac{\text{wet tons}}{\text{acre}} \times \frac{2000 \text{ lbs}}{\text{ton}} \times \frac{1 \text{ gal}}{8.34 \text{ lbs}}$$

$$\text{mg/l (dry)} = \text{mg/l (wet)} \times \frac{100}{\% \text{ Total Solids}}$$

$$\text{Dry Tons} = \text{Wet Tons} \times \frac{\% \text{ Total Solids}}{100}$$

$$\text{Plant Available Nitrogen(PAN)(mg/kg)} = \text{Ammonia Nitrogen(mg/kg)} + \text{Organic Nitrogen(mg/kg)}$$

Organic Nitrogen(mg/kg) = Total Kjeldahl Nitrogen(TKN)(mg/kg) - Ammonia Nitrogen(mg/kg)

WEST PROCESS CONTROL METHOD FOR ACTIVATED SLUDGE

$$F = 31.2 \text{ lbs/ft}^3 \times H^2 \times L$$

$$R_Q = \frac{MLSS \times Q}{RAS} \times \frac{1 - \frac{MLSS}{RAS}}$$

$$CFP = \frac{ATC - FEC}{RSC - ATC}$$

$$R_Q = \frac{Q \times M}{\frac{1,000,000}{SVI} - M}$$

$$ATC = \frac{(CFP \times RSC) + FEC}{CFP + 1.0}$$

$$WCR = \frac{MLTSS}{ATC}$$

$$RSC = \frac{ATC + (ATC - FEC)}{CFP}$$

$$SLU = \frac{\text{Volume} \times \text{Centrifuged Concentration}}{100}$$

$$RSP = \frac{ATC - PEC}{RSC - ATC}$$

$$SSC = \frac{1000 \times ATC}{SSV}$$

$$ATC = \frac{(RSP \times RSC) + PEC}{RSP + 1.0}$$

$$CFP = \frac{ATC}{(RSC - ATC)}$$

$$RSC = \frac{ATC + (ATC - PEC)}{RSP}$$

$$ATC = \frac{CFP \times RSC}{CFP + 1.0}$$

$$CSU = \frac{BLV \times CSC}{100}$$

$$RSC = ATC + \frac{(ATC)}{CFP}$$

$$CDT = \frac{CV \times 24}{CFI}$$

$$ASU = \frac{AV \times ATC}{100}$$

$$CSDT = \frac{CSU}{CSUO}$$

$$RSU = \frac{RSF \times RSC}{100}$$

$$OFR = \frac{CFO}{CFA}$$

$$ADT @ AFI = \frac{AV \times 24}{AFI}$$

$$SAH = \frac{ADT \times 24}{ADT + CSDT}$$

$$ADT @ TFL = \frac{AV \times 24}{AFI + RSF}$$

$$AGE = \frac{ASU + CSU}{TXU/\text{day}}$$

$$CSFD = \frac{RSF \times (RSC - ATC)}{SSC - ATC}$$

$$AAG = \frac{AGE \times SAH}{24}$$

$$SCR = \frac{SSC60}{RSC}$$

| | | | |
|-------|---|-----|---|
| AAG | - Aeration Age | OFR | - Final Clarifier Surface Overflow Rate |
| ADT | - Aeration Tank Detention Time | PEC | - Primary Effluent Concentration |
| AFI | - Aeration Tank Wastewater Flow(In) | RAS | - Return Activated Sludge |
| AGE | - Sludge Age | RSC | - Return Sludge Concentration |
| ASU | - Aeration Tank Sludge Units | RSF | - Return Sludge Flow |
| ATC | - Aeration Tank Concentration | RSP | - Return Sludge Percentage |
| AV | - Aeration Tank Volume | RSU | - Return Sludge Units |
| BLV | - Sludge Blanket Volume | SAH | - Sludge Aeration Hours |
| CDT | - Final Clarifier Detention Time | SCR | - Sludge Concentration Ratio |
| CFA | - Final Clarifier Area | SLU | - Sludge Units |
| CFI | - Final Clarifier Flow(In) | SSC | - Settled Sludge Concentration |
| CFO | - Final Clarifier Flow(Out) | SSV | - Settled Sludge Volume |
| CFP | - Final Clarifier Sludge Flow Percentage | SVI | - Sludge Volume Index |
| CSC | - Final Clarifier Sludge Concentration | TFL | - Total Flow |
| CSDT | - Final Clarifier Sludge Detention Time | TXU | - Total Excess Sludge Units to Waste |
| CSF | - Final Clarifier Sludge Flow | VSS | - Volatile Suspended Solids |
| CSFD | - Final Clarifier Sludge Flow Demand | WAS | - Waste Activated Sludge |
| CSU | - Final Clarifier Sludge Units | WCR | - Sludge Weight to Concentration Ratio |
| CSUO | - Final Clarifier Sludge Units Out of Clarifier | XFP | - Excess Sludge Flow |
| CV | - Final Clarifier Volume | XSC | - Excess Sludge Concentration |
| FEC | - Final Effluent Solids Concentration | XSF | - Excess Sludge Flow to Waste |
| MCRT | - Mean Cell Residence Time | XSU | - Total Excess Sludge Units to Waste |
| MLSS | - Mixed Liquor Suspended Solids | | |
| MLTSS | - Mixed Liquor Total Suspended Solids | | |
| MLVSS | - Mixed Liquor Volatile Suspended Solids | | |