

# **IDEM Wastewater Operator Examination**

## **Study Guide**

### **Class 1 and Class A Exams**

April 2021

As you prepare for the Municipal Class 1 and Industrial Class A exams, you will need to focus your study on Books 1, 2 and 10 as listed on the IDEM Wastewater Operator Certification Exam Book List web page. These reference materials have been used in developing the examination questions which you will need to be able to answer. Books 1 and 2 are manuals prepared by and available through California State University, Sacramento College of Engineering and Computer Science, Office of Water Programs (Referred to hereafter as the Sacramento manuals), which can be purchased at: <https://www.owp.csus.edu/courses/wastewater.php>

Book 10 is IDEM's Wastewater Operator Certification Manual found at:  
[https://www.in.gov/idem/cleanwater/files/wastewater\\_cert\\_booklist\\_10\\_manual.pdf](https://www.in.gov/idem/cleanwater/files/wastewater_cert_booklist_10_manual.pdf)

This document is designed to guide you to the subject matter that you will need to be familiar with in order to pass the test. While this covers a wide range of material, you should keep in mind that the exam consists of only 100 multiple choice questions, you do not need to study every chapter of these books, and since you have been working at a wastewater treatment plant for some time, much of this will already be familiar to you. You can do this! The breakdown of the distribution of the questions is described below.

Categories of test questions which will be covered by the Sacramento manuals and the approximate percentage of the examination questions comprised from that area are listed below:

Activated Sludge 15-20%

Clarifiers 5%

Collection system 2%

Disinfection 6%

Laboratory 10%

Maintenance 5%

Preliminary treatment 5%

Safety 6%

Solids Handling 3%

### **Operation of Wastewater Treatment Plants - Volume I**

Questions on the Class I and Class A examination are taken from the following chapters:

**Chapter 1** Introduction to Wastewater Treatment

**Chapter 2** Safety

**Chapter 3** Preliminary Treatment

**Chapter 4** Primary Treatment

**Chapter 5** Activated Sludge Systems

**Chapter 7** Disinfection  
**Chapter 8** Lagoon Systems  
**Chapter 9** Laboratory Procedures

## **Operation of Wastewater Treatment Plants - Volume II**

**Chapter 11** Activated Sludge (Operation of Conventional Activated Sludge Plants)  
**Chapter 12** Sludge Digestion and Solids Handling  
**Chapter 13** Effluent Discharge, Reclamation, and Reuse  
**Chapter 14** Plant Safety  
**Chapter 15** Maintenance  
**Chapter 16** Laboratory Procedures and Chemistry  
**Chapter 18** Analysis and Presentation of Data

### **Other subject matter that will be found on the test includes:**

***Mathematics*** 10 - 15 %

Mathematics problems given on the examination will have a corresponding formula listed on the Formula Sheet furnished with the exam on your test day. It is recommended that you look over the formula sheets and work the problems in the Appendices in Volumes 1 and 2 of the Sacramento manuals. Solving these problems involves plugging the numbers given in the problem into the correct formula and calculating the answer.

There are a few basic rules that apply to solving formulas:

1. Work from left to right
2. Do all of the multiplication and division above the line (in the numerator) and below the line (in the denominator); then do the addition and subtraction above and below the line.
3. Perform the division (divide the numerator by the denominator).
4. Parentheses ( ) are used in formulas to identify separate parts of a problem. Work the arithmetic within the parentheses before working outside the parentheses. Use the same order stated in rules 1, 2, and 3 above when working inside of parentheses.

Web site for the Formula Sheet:

[https://www.in.gov/idem/cleanwater/files/wastewater\\_cert\\_study\\_guide\\_formula\\_sheet.pdf](https://www.in.gov/idem/cleanwater/files/wastewater_cert_study_guide_formula_sheet.pdf)

### **Rules/Completing Reports** 20 - 25%

The remainder of the examination questions will cover the applicable rules and completion of monthly reports. Practice questions on Rules are covered extensively in Chapter III, Section One, of the Wastewater Operator Certification Manual.

There will also be questions related to completion of the Discharge Monitoring Report (DMR) and the Monthly Report of Operation (MRO). A worksheet and necessary additional documents are incorporated into the Certification Manual as Appendices A, B, C, and D to help prepare you for the exam.

## **Subject Matter Topics**

The following is subject matter that an operator should be familiar with. You should be able to answer questions on the points presented below. Of course, not all of this will appear on any given test, but some of it will appear on all tests.

### **Activated Sludge**

Define first stage and second stage BOD relative to nitrification (carbonaceous versus nitrogenous BOD removals).

Describe where the activated sludge process fits in the wastewater treatment flow pathway.

Define the activated sludge process.

Describe the secondary treatment process of activated sludge systems.

Define the role microorganisms have in the activated sludge process.

Identify and explain the meaning of the following terms:

- MLSS
- SVI
- WAS
- RAS

List the important conditions necessary for optimum bacterial growth in an aeration basin of activated sludge systems.

Draw a diagram of the secondary activated sludge process and name the components.

Describe the relationship among D.O., BOD loadings, floc settleability, filamentous bacteria and pinpoint floc.

Why is sludge wasting important in an activated sludge system?

List the main controls an operator has over the activated sludge processes.

Describe the layout of the common type of extended aeration tanks.

What is the definition of sludge age and what is the expected sludge age in an extended aeration process?

Describe the differences among and advantages/disadvantages of conventional activated sludge, extended aeration, contact stabilization and complete mix systems. For example, which of the four processes has the longest detention time? What are the advantages of the longer detention time?

What is the function of cathodic protection for a metal-built package plant?

Which two methods of aeration are commonly used in the activated sludge process? Describe the mechanism of aeration.

What are the advantages and disadvantages of fine bubble air systems?

What can happen if not enough air is supplied to an activated sludge system?

In the activated sludge systems, foam can appear on the surface of the aeration tank. How could the color of foam indicate the condition of the aerator?

Explain sludge wasting:

- How to dispose of excess sludge
- What is the consequence of NOT wasting sludge?

Describe the normal operation of an activated sludge plant.

Describe the abnormal operation of an activated sludge system.

Describe troubleshooting of activated sludge systems.

Describe the settling test for activated sludge and explain how the results of the test should be used to control the plant operation.

Describe the flow path and major components of oxidation ditches.

Explain why the oxidation ditch process is less affected by cold weather than the conventional activated sludge processes?

What is the result of wasting sludge from an oxidation ditch system?

At what velocity does the liquid in an oxidation ditch need to be maintained and why?

How is the dissolved oxygen level in oxidation ditches controlled?

To build up MLSS in an oxidation ditch in order for foam reduction, what control should be manipulated?

What is the most essential component of an oxidation ditch and why?

Discuss essential design features of package plants.

Explain the term "endogenous respiration".

What types of laboratory data are needed to be recorded for proper operation of an activated sludge process?

Define the term "organic loading". Compare the organic loadings of different activated sludge processes.

Describe three types of air diffusers in activated sludge systems. What are their advantages and disadvantages?

What level of D.O. should be maintained in an aeration tank of an activated sludge system? Where should this level be maintained?

Describe what will happen when the return sludge rate is too low in an activated sludge system.

Describe what would happen if the mixed liquor suspended solids are allowed to increase beyond the optimum range in an activated sludge system.

Describe the term "sludge bulking".

Explain why sludge may turn septic in an activated sludge system.

Describe rising sludge in an activated sludge system. What causes rising sludge?

Explain why activated sludge is called a "mixed culture".

Describe the microorganisms found in an activated sludge system.

Which is the 'main worker' among the various organisms found in activated sludge?

### **Clarifiers/Sedimentation**

Describe the purpose of sedimentation.

Differentiate between primary and secondary (or final) clarifiers.

Describe the essential components of a rectangular clarifier.

Describe the essential components of a circular clarifier.

What is the purpose of the effluent weir in a circular clarifier?

Black and odorous septic wastewater is leaving the primary clarifier of your wastewater plant. What could be the causes and their solutions?

You found that sludge was hard to pump from the hopper of the secondary clarifiers. What could be the causes and their solutions?

Excessive corrosion is observed on the clarifier of your package extended aeration unit. What could be the causes and their solutions?

At what location would you collect samples in order to determine the efficiency of a clarifier?

What water quality parameter should be measured to determine the efficiency of a clarifier?

Describe the factors affecting clarifier efficiencies.

Describe the method to determine the proper intervals of sludge pumping from a clarifier.

Describe the proper maintenance program for a clarifier.

Define specific gravity.

Describe the temperature effect on sedimentation of a particle in a clarifier.

Describe short-circuiting in a clarifier.

Discuss secondary clarifiers.

What are the common causes of short-circuiting in a clarifier and their remedial measures?

Describe the relationship between the detention time and particle settling rates in a clarifier.

Describe why it is important to know weir overflow rates in a clarifier.

Define surface settling rates in a clarifier.

Explain the "hydrostatic" sludge removal system.

Describe the layout of an activated sludge plant and the location of secondary clarifiers.

Describe three variations of sludge removal mechanisms.

What will happen if sludge is allowed to stay in a secondary clarifier too long? What is the solution?

## **Disinfection**

What are pathogenic organisms?

Describe the difference between the terms "disinfection" and "sterilization".

Describe the reaction of chlorine in wastewater. What is "chlorine demand"?

Describe the reaction of chlorine with ammonia. What are the names of the reaction products?

Describe factors affecting disinfection of wastewater by chlorine.

Describe "post-chlorination".

Discuss the importance of mixing chlorine in a chlorine contact tank.

Discuss four methods of chlorine residual measurement.

Discuss the hazards in handling chlorine gas.

Describe the type of breathing apparatus necessary when entering a room with a chlorine leak.

Discuss the handling of chlorine cylinders.

Describe a "hypochlorinator".

Discuss the need for dechlorination.

What methods are available for dechlorination?

Discuss the properties of sulfur dioxide.

Discuss the typical application point of sulfur dioxide for dechlorination.

Understand how UV disinfection works.

Understand what kind of light is used in UV disinfection.

## **Laboratory, Sampling and Monitoring**

Describe the following terms used in laboratory analyses.

- buffer & buffer capacity
- meniscus

- N (Normal)

Explain the relationship between Celsius and Fahrenheit temperature scales. What are the boiling temperatures of water in degrees Celsius and degrees Fahrenheit?

Discuss the metric system.

List the chemical formulas of the following compounds:

- sodium chloride
- sodium hydroxide
- sulfuric acid
- ferric chloride

Describe the functions of the following lab equipment:

- beakers
- graduated cylinders
- volumetric pipet
- Buchner funnel
- buret

State the function of a desiccator.

Explain the different uses of flasks and volumetric flasks.

Explain the proper method of use of three types of pipets.

Describe laboratory work (bench) sheets.

Discuss laboratory safety at a wastewater treatment plant laboratory.

Discuss the safe storage of laboratory chemicals as it relates to proper location and the compatibility of various types of chemicals.

Explain the following units of concentration used in recording laboratory data:

- mg/l
- mg/kg
- % solids

Describe proper fire prevention measures necessary at a wastewater treatment plant laboratory.

Discuss the accuracy expected from the use of analytical balances and graduated cylinders.

Describe proper laboratory techniques in handling acids and mercury.

Explain why it is important to collect samples correctly.

Discuss the importance of composite samples and their use in the laboratory tests.

Explain grab samples and composite samples.

Describe the proper sample preservation methods and the maximum recommended holding time for the following tests:

- ammonia
- BOD
- pH
- chlorine
- Total Suspended Solids (TSS)

Specify temperature requirements in degrees C (Celsius) for each of the following:

- BOD incubator
- TSS drying oven
- refrigerator
- composite sampler
- muffle furnace

Discuss the production and hazard of hydrogen sulfide in the sewer and at wastewater treatment plants.

Discuss how a Secchi disc can be used at a wastewater treatment plant.

Describe precautions one needs to take in running tests for suspended solids.

Describe settleability tests, and how the results can be used in plant process control.

Explain the difference between the settleable solids test and the settleability test, the method and the use of information.

Discuss the measurement of the sludge volume index and its application in the activated sludge processes.

Discuss the determination of "sludge age".

Why are we concerned about the concentration of coliform group bacteria?

Why is it important to maintain residual chlorine in a chlorine contact tank?

Describe the precautions necessary in the use of a D.O. probe for BOD tests.

Explain the meaning of BOD.

Describe the procedure for BOD measurement.

What are the requirements of the minimum depletion and the minimum residual D.O. in BOD tests?

Explain the relationship between temperature and percent saturation with regard to dissolved oxygen.

Describe precautions required in the BOD tests.

"Blank tests" in BOD measurement are a requirement. What is the purpose?



What does the term “pH” represent? What is the range of pH? What is the neutral pH?

What are the precautions one should take in the pH measurement?

Discuss what is measured in laboratory water when it is tested for specific conductance.

Discuss the importance of temperature measurement. How is a thermometer calibrated?

## **Preliminary Treatment**

Identify three different types of preliminary treatment and describe the purpose of each.

Define “grit” and “detritus”.

Describe methods for the ultimate disposal of screenings.

Describe the purpose and essential parts of comminutors.

Describe the composition of grit.

Describe the purpose of grit channels and proportional weirs.

Describe aerated grit chambers. What are the side benefits of aerated grit chambers?

Describe the final disposal methods of grit.

What are the benefits of pre-aeration?

If screens or comminutors are overloaded or bypassed, what problems can one expect?

## **Safety and Maintenance**

What precautions should be taken against the risk of infection by operators at a wastewater treatment plant?

Discuss the dangerous gasses encountered in sewers and wastewater treatment plants.

Discuss Material Safety Data Sheets (MSDS).

Describe the proper way to remove a manhole cover.

What is the greatest hazard when working on a clarifier?

Describe how one can locate chlorine leaks in a chlorination system.

Describe the function of leaking water in a packing gland for a pump.

Describe the water level control system found in a wet-well of a piping system.

Compare mechanical seals and packings in a pumping system.

Describe the air-gap system for water supply at a wastewater treatment plant.

Explain the concern for cross-connection in a pumping system.

Describe the possible causes when a pump will not start.

What should one check if the flow rate of a centrifugal pump is reduced?

How would you determine the schedule of lubrication for a pump?

What could cause a pump shaft and motor to spin backward?

Compare positive displacement pumps with centrifugal pumps. Where are positive displacement pumps used and what is the most important thing to remember in their operation?

Compare two types of blowers.

Why are fine bubble diffusers easily clogged?

Describe two types of headers in the aeration system.

Why is an oil cooler unit sometimes used for centrifugal blowers?

What precautions should be taken when working with blowers?

Can you clean air filters while a blower is in operation?

Define "velocity" and  $Q=AV$ .

Describe flume-type head-area meters. What is their application in a wastewater treatment plant?

Describe weir-type head-area meters. What is their application in a wastewater treatment plant?

What are the purposes of flow measurement at a wastewater treatment plant?

## **Solids Treatment & Handling**

Explain the sludge digestion process.

Describe the anaerobic sludge digestion process and its purpose.

Describe the aerobic sludge digestion process.

Compare the aerobic and anaerobic digestion processes.

Describe the relationship between aerobic digestion and endogenous respiration.

Describe the operational procedures of aerobic digesters.

Describe how floating sludge can affect the operation of aerobic digesters.

Describe construction of sludge drying beds.

Describe the operation of a sludge drying bed.

Describe the types of mechanical dewatering methods available.

Describe five methods of final disposal of sludge.

## **Mathematics**

Given the volume of a sedimentation tank and the flow rate, calculate the detention time of the sedimentation tank.

Given a flow rate in gpm, convert it into MGD.

Given the distance and time of travel of a stick in a grit channel, calculate the velocity of travel.

Given the influent and effluent TSS, calculate the TSS removal efficiency in percent.

Given the concentration of MLSS and the volume of an oxidation ditch, calculate the pounds of solids under aeration.

Given the influent BOD and the required percent removal, calculate the required maximum effluent BOD.

Given the dimensions of an aeration tank (circular), calculate the volume of the tank.

Given the 30 minute settleable solids (%) and MLSS, calculate the sludge volume index.

Given the flow totalizer readings at the beginning and end of a month (30 days), calculate an average flow rate for the month.

Given the effluent BOD in mg/l and an effluent flow rate, calculate the BOD loading to a receiving stream in pounds per day.

Given the influent and effluent TSS of a wastewater plant, calculate the overall TSS removal efficiency.

Given the TSS of a primary effluent, the daily flow and the total solids (pounds) in an aeration tank, calculate the sludge age.

Given the estimated BOD of a sample, calculate the ml of sample to be added to a BOD bottle (300 ml).

Given the sample volume of a BOD test, the initial D.O. and the final D.O., calculate the sample BOD.

Given six BOD values in mg/l, calculate the mean BOD in mg/L.

Given the flow rate and the desired dosage of chlorine, calculate the chlorine feed rate in pounds per hour.

Given test results on the TSS determination using a Gooch crucible (sample volume, crucible weight w/ and w/o residue), calculate the TSS in mg/l.

Given the required chlorine feed rate and the strength of HTH (high test hypochlorite), calculate the pounds/day of HTH required.

Given the volume of water in liters, calculate its weight in grams.

**We at IDEM wish you success and hope to be seeing you out there working to protect Indiana's waters and the infrastructure investments in wastewater facilities. Now, go pass that test!**