

Certification Examination

Study Guide

Collection System Maintenance Grade IV

2nd Edition



New 2nd Edition

- * Revised for 2011 tests.
- * New KSA descriptions including KSA weighting.
- * Expanded practice test and solutions.
- * Searchable text optimized for electronic reading.



California
Water
Environment
Association



Collection System Maintenance Grade IV Study Guide, 2nd Edition

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Appendix A: You and Wastewater Math

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Cover Photo Courtesy of Orange County Sanitation District

Important Notice: CWEA is pleased that you have purchased this book. We want to remind you that this book is one of many resources available to assist you and encourage you to identify and utilize the other resources in preparing for your next test.

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Grade IV Collection System Maintenance Study Guide

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Introduction

What to Expect From This Study Guide

The purpose of this study guide is to help certificate candidates understand what is expected of them on the certification test and to help them identify resources to assist in preparation for the test. It is not a comprehensive text on the wide variety of topics covered on the certification test. Successful candidates should expect to spend significant time reading and reviewing additional materials listed in this study guide along with any other materials available that can help them understand the subject matter of the test. In addition, successful preparation strategies include attending study sessions, participating in study groups, and completing relevant vocational and college courses. Ultimately, the amount of preparation required to pass the test depends on a candidate's education, training, and work experience. After reviewing this study guide, you should be able to determine what you need to do to prepare for the test and how much time you will need (months are often required).

About the CWEA Certification Program

The California Water Environment Association (CWEA) Technical Certification Program (TCP) is either required or encouraged by many wastewater employers. Its purpose is to set a standard of the essential requirements for an individual to perform a given job safely and effectively, and to provide a measure of competency through certification testing. The certification test focuses on the Knowledge, Skills, and Abilities (KSAs) an individual must master to perform their job safely and effectively.

CWEA certifies personnel in six vocations:

- Plant Maintenance Technologist (with two parallel specialties of Electrical/ Instrumentation, and Mechanical Technologist)
- Laboratory Analyst
- Collection System Maintenance Technologist
- Environmental Compliance Inspector
- Industrial Waste Treatment Plant Operator
- Biosolids Land Application Management

Upon qualifying and successfully completing the certification test, an individual becomes certified in that specialty at that grade level. Grade levels within a vocation designate technical knowledge for the entry-level, apprentice, journey, and management levels. More information about minimum qualifications can be found in the Candidate Handbook for your vocation available at www.cwea.org/cert or calling 510-382-7800.

Much of the CWEA mission is dedicated to providing education and training in all aspects of the wastewater industry including the KSAs of each certification vocation. CWEA is careful to separate its education and training activities from its certification activities to ensure that the educational focus is on the KSAs wastewater professional need to know to perform their jobs rather than being narrowly focused on just passing the certification test.



Certification Program and Policies

CWEA's mission is to enhance the education and effectiveness of California wastewater professionals through training, certification, dissemination of technical information, and promotion of sound policies to benefit society through protection and enhancement of the water environment.

CWEA is a California Nonprofit Corporation, a Member Association of the Water Environment Federation (WEF), and a member of the Institute of Credentialing Excellence (ICE).

Technical Certification Program History

TCP was created to offer multilevel technical certification for individuals employed in the water quality field. Tests are written by vocational specialists and administered year round in six different vocations: Collection System Maintenance, Environmental Compliance Inspection, Laboratory Analysis, Plant Maintenance (Electrical/Instrumentation and Mechanical Technologist), Industrial Waste Treatment Plant Operation, and Biosolids Land Application Management.

CWEA first offered a certification program for wastewater treatment plant operators in 1937. The program was administered by CWEA until 1973 when the State of California assumed responsibility. During those 36 years, CWEA awarded 3,915 operator certificates.

CWEA established its Line Maintenance certification program in 1964. Eventually that would become the Collection System Maintenance certification program. In 1974 the first committees were formed to establish a voluntary certification program for water quality professionals specializing in disciplines other than plant operation. The following year the State Water Resources Control Board suggested that CWEA implement an industrial waste pretreatment certification program. TCP, then known as the Voluntary Certification Program or VCP, emerged in 1976 with specialized certificate programs for Plant Maintenance, Environmental Compliance Inspection, and Laboratory Analysis with certifications first issued in April 1976. In the 1980s, two more disciplines were added: Electrical/Instrumentation and Industrial Waste Treatment Plant Operator.

Today, CWEA offers certification in vocational programs with a total of 23 individual certifications. About 2,000 applications are processed annually and currently over 5,500 certificates are held by individuals primarily in California. CWEA also partners with other WEF Member Associations to offer certification in Michigan, Hawaii, and Missouri.

Certification Process

To become certified, *all applicants* must complete the Application for Technical Certification, pay the application fee, meet minimum qualifications regarding professional experience and education, and pass the computer-based test. Application instructions and fee schedules are listed on the application. After applications are received at the CWEA office, applicant information is compiled in a database, and reviewed by CWEA staff and experts in the field. If timing permits, staff will work with the applicant to resolve any incomplete applications. When approved, the applicant will receive an acceptance letter and test registration and scheduling instructions.



Immediately after completion of the computer-based test, a preliminary score and result will be given at the testing center. Occasionally, the official results may be adjusted from the preliminary results to resolve scoring issues. Official results are mailed to candidates. Those who pass the test, are mailed certificates and blue wallet cards (also known simply as “blue cards”).

Test Administration

Test Dates and Sites

Tests are given throughout the year within four quarterly windows (see Application for Technical Certification for test schedule). Applicants who are eligible to take the test are mailed an acceptance letter with instructions on how to schedule their exam.

Test Site Admission

Certificate candidates are required to show at least one valid government issued photo identification (state driver’s license or identification, or passport). Only after positive identification has been made by the testing proctor can a candidate be allowed to take a CWEA cert test. Be sure the name on your acceptance letter matches your identification or you could be turned away at the test center. If your name does not match, contact the CWEA office mediately. Candidates are not require to show their eligibility letters to enter the test site.

Test Security

All tests are computer-based. No reference material, laptop computers, cameras or other personal items are allowed in the test site (see the test site policy at www.cwea.org/cbt). Candidates will have access to an on-screen calculator. However, candidates are welcome to bring their own calculator as long as it is on the list of approved calculators (visit www.cwea.org/cbt). Candidates are not permitted to take any notes from the test site. Candidates who violate test site rules will be asked to leave the site and may be disqualified from that test. All violations of test security will be investigated by CWEA and appropriate action will be taken.

Test Rescheduling and Cancellation

To reschedule your application, you must submit a written request stating that you wish to postpone to the adjacent testing window. You may only reschedule your application to the adjacent window once without a fee. Additional postponement will requires a reschedule fee. There are no exceptions to this policy.

To cancel your application you must submit a written request to CWEA. The written request must be received at the CWEA office no later than 2 weeks after the approved test window begins. Full re-funds, less the administrative fee, will be made within 4 weeks after the scheduled test date. There are no exceptions to this policy.

If you already have a scheduled exam with our testing partner, Pearson VUE, and need to cancel your appointment, you must contact them 24 hours in advance to avoid losing your exam fee

Test Result Notification

Official test results are routinely mailed to certificate candidates approximately two weeks after the test date. Results are never given over the phone, via fax or email. All results are confidential and are only released to the certificate candidate.



Issue of Certificate/ Blue Wallet Card

Certificates and blue wallet cards are issued to all candidates who pass the test. Certificates and blue wallet cards are mailed within three weeks after result notifications are mailed.

Certificate Renewal

All certificates are renewable annually. The first renewal is due one year from the last day of the month in which the certification test was held. Certificate renewals less than one year past due are subject to the renewal fee plus \$25 late fee. Certificates more than two years past due are only renewable through retesting. Renewal notices are mailed to certificate holders two months before the due date. It is the responsibility of certificate holders to ensure the certificate(s) remains valid. Every other year, certificate holders are required to submit 12 contact hours of education or training relevant to the certificate held. Continuing Education is required to help ensure that individuals certified by CWEA continue to be knowledgeable of technological advancements and regulatory requirements in the wastewater fields. Continuing education enhances the operation, maintenance and management skills of the certificate holders, and ensures the quality of wastewater treatment. This ultimately increases the ability and confidence of certificate holders and the credibility of the wastewater professions certified by CWEA.

Accommodations for Physical or Learning Disabilities

In compliance with the Americans with Disabilities Act, special accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect an individual's ability to successfully complete the certification test. Written requests for special accommodations must be made with the test application along with all supporting documents of disability. Applicants requesting accommodations are encouraged to apply as early as possible to ensure sufficient time to process the request.

Test Design and Format

Test Design

All certification tests are designed to test knowledge and abilities required to perform the KSAs listed at the end of the section with minimal acceptable competence.

The KSAs were determined by a job analysis and meta-analysis of job specifications by experts in the field under the guidance of test development specialists. The studies gathered data from on-site visits of over 31 water and wastewater agencies, interviews with 110 water and wastewater professionals, and analysis of more than 300 job specifications. All research was conducted under the guidance of the TCP Committee, vocational subcommittees, and CWEA staff. All test questions are designed to measure at least one area of knowledge or ability that is required to perform an essential duty.



Test Delivery Mechanism

All tests are computer-based format and are available in the English language only. Tests are delivered at Pearson VUE testing centers.

Test Format

All TCP tests are in multiple choice format (see the sample test questions in this booklet for an example). The multiple choice format is considered the most effective for use in standardized tests. This objective format allows a greater content coverage for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Test Pass Point

The minimum score required to pass varies depending on the test and possible total points. The score may be adjusted downward depending on test complexity. It should be assumed that if the passing score is 75 percent candidates should try to score as high as possible on their test (in other words, always try for 100 percent). The pass point for each vocation and grade level is set independently. Also, each version, or form of a test will have its own pass point. Different versions are given each time the certification test is administered.

How Pass Points are Set

A modified *Angoff Method* is used to determine the pass point for each version of each test. The modified *Angoff Method* uses expert judgements to determine the test difficulty. The easier the test, the higher the pass point; similarly the more difficult the test, the lower the pass point.

The following is an outline of the modified *Angoff Method* (some details have been omitted):

1. A group of Subject Matter Experts (SMEs) independently rate each test question within a given test. The ratings are defined as the probability that an acceptably (minimally) competent person with the requisite education and experience will answer the question correctly. An acceptably (minimally) competent person is defined as someone who safely and adequately performs all job functions and requires no further training to do so.
2. The SMEs review each test question as a group. A consensus is reached for the rating of each test question. The SMEs also review comments submitted in writing by test-takers. Any test question that is judged to be ambiguous, has more than one correct answer, or has no correct answers is eliminated from the scoring process for that test. These test questions are then revised for future use, reclassified, or deleted from the test item bank.
3. After the data are refined, the final step is to calculate the mean, or average, of all the test question ratings. This becomes the overall pass point estimation.

Why Use Modified Angoff?

Each version of a given certification test uses questions from a test item bank. Each of these questions vary in difficulty. Because a different mix of questions is used in each test, the overall difficulty level is not fixed. Thus, it is important to make sure that the varying difficulty level is reflected in the pass point of each test to ensure that test results are reliable. Test reliability is concerned with the reproducibility of results for each version of a given test. In other words, for a test to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine taking a certain grade level test and passing it. Immediately after completing this test, a different version of the same grade level test is taken. If the test is reliable, the same result will



be achieved: pass. If a passing grade is not achieved, it is likely that the test is not a reliable measure of acceptable (minimal) competency.

By taking into consideration the difficulty of the test, the modified *Angoff Method* significantly increases the reliability of the test. Also, since each test is adjusted for difficulty level, each test version has the same standard for passing. Thus, test-takers are treated equitably and fairly, even if a different version of the test is taken.

There are other methods for setting pass points. However, for the type of tests administered by CWEA, the modified *Angoff Method* is the best and most widely used.

Test Scoring

All tests are electronically scored by Pearson VUE pending approval by CWEA. Most test items are valued at one point. Some test items requiring calculations are worth multiple points varying from two to five (possibly more). After tests are scored, total points are compiled and an overall score is calculated as the sum of all points earned on the test. If the overall score is equal to, or greater than the established pass point, the candidate has passed the test. Total points possible for each test varies, but the average is 100 points plus or minus 25.

Item Appeals

Candidates who wish to appeal a specific test item must do so during the test by completing the *Candidate Comment Review Section* during the exam. Item appeals will be evaluated and appropriate adjustments will be made to the test content. Candidates submitting comments will not be contacted in regards to the appeal.



Knowledge, Skills, & Abilities (KSAs)

Understanding The KSAs

The key to success on the CWEA certification test is understanding the KSAs and having adequate training, education, and experience in those KSAs. Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual Grade IV position description, they do reflect the core competencies and essential duties required of Grade IV Collection System Maintenance Technologists employed by any collection system. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

This section outlines each KSA and includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered. Although each candidate is encouraged to find educational opportunities that suits his or her needs best, typical educational opportunities include:

- On the job training
- Print or online training materials
- Manuals of practice, technical documents, regulations, etc.
- Mentoring
- Trade, vocational, or college courses
- Professional education sessions and seminars

Candidates seeking Collection System Maintenance Grade IV certification should review the KSAs presented in this section and seek to understand how they apply to everyday duties and responsibilities.

KSA Weight

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

General Competencies and Math Competencies

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

Suggested Reading

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.



KSA 400

Weight: 5%

Have a working knowledge and understanding of the essential duties identified on the Test Content Specifications for Collection Systems Grades I, II and III.

KSA400 General Competencies

A person at the Collection System Maintenance Grade IV level is generally considered to be an integral portion of an agency's management structure. As such they are not expected to perform the actual field duties of a Collection System Worker at the Grade I and II levels, but they may perform the supervisory duties of Collection System Worker at the Grade III level. Notwithstanding, they must have a working knowledge and understanding of all elements of wastewater collection system maintenance. This may include, but is not limited to, operation of equipment such as:

- high-velocity sewer cleaners.
- mechanical rodding machines.
- hydraulic winches.
- compressors.
- construction equipment.

Essential duties include the performing tasks such as:

- inspections of wastewater collection system lift/pump stations to ensure the proper operation of such facilities.
- maintaining sewers located on private property, remote canyons, environmentally sensitive areas, and unimproved areas.
- performing a wide variety of construction activities such as replacing damaged pipes, repairing damaged maintenance structures or raising maintenance structures to grade after paving activities.
- responding to customer service requests and performing other related duties.

Grade IV technologists should have a good understanding of more advanced maintenance duties that are utilized to support condition assessment programs. These duties may include:

- performing Closed Circuit Television (CCTV) equipment to visually inspect sewer pipes.
- smoke testing to determine sources of inflow, infiltration or illicit connections.
- flow monitoring.
- chemical root control.
- odor and corrosion abatement.
- pesticide application to control insects or rodents.



- ultrasonic measurement to determine pipe condition.

This knowledge is gained through a number of sources ranging from basic in-house training to specialized training from outside sources such as vendors or professional trade related agencies.

KSA400 Math Competencies

In order to fully understand these duties a Collection System Manager must be able to perform a wide variety of mathematical calculations to determine volume, area, distances, slopes and flow rates. Additionally they must have knowledge of agency specific data management systems such as condition assessment, record keeping and mapping systems.

KSA400 Suggested Reading

- *Operation and Maintenance of Wastewater Collections Systems, Volume 1, 6th Edition.*
- *Operation and Maintenance of Wastewater Collections Systems, Volume 2, 7th Edition.*
- *Confined Space Entry, WEF, Second Edition, 1998*
- *Safety and Health in Wastewater Systems, WEF, 1994*
- *Mathematics for Collection System Operators - a Workshop Manual, OCT Inc., 2010.*
- *Supervision - Concepts and Practices of Management.*
- *Wastewater Collection System Maintenance.*

KSA 401

Weight: 5%

Administers and manages the work performance and duties of Collection System Maintenance Grades I, II, and III personnel.

KSA401 General Competencies

As a Collection System Manager a person at this level is expected to monitor the performance of others engaged in collection system maintenance activities. This may include tracking status of operation and maintenance activities by utilizing a variety of sources such as daily work logs, computerized work management programs and/or agency specific computerized maintenance management programs. This knowledge is usually gained through advanced in-house training, college level courses, vendors and professional trade related agencies.

KSA401 Math Competencies

Managers must have excellent mathematical skills and be able to perform calculations to determine percentage of work completed, individual performance by crew as compared to established standards, determine number of work hours/days required to complete required tasks and develop work schedules based on established performance levels.



KSA401 Suggested Reading

- *Manage for Success*, Chapter 1, (All); Chapter 10, pages 311 – 317
- *Utility Management*, Chapter 10, (All)
- *Mathematics for Collection System Operators – a Workshop Manual*
- *Wastewater Collection System Maintenance*, Chapter 12, (All).

KSA 402

Weight: 5%

Responsible for assigned services and activities associated with the operation, maintenance and repair of the wastewater collection system.

KSA402 General Competencies

The success of a maintenance program for any organization is dependant upon a Manager's ability to plan, organize and direct operation and maintenance programs. This requires a manager to:

- direct the long range planning of operation/maintenance programs.
- ensure coordination of operation and maintenance activities for crafts, operations, contractors and engineering personnel.
- track status of operation and maintenance activities in support of work programs.
- prepare/review operation/maintenance policies, procedures, schedules and strategies with all personnel and directly supervise emergency bypass operations or other "highly visible" work.

This knowledge is usually gained through advanced in-house training, college level courses, vendors and professional trade related agencies.

KSA402 Math Competencies

There are no specific math competencies for this KSA.

KSA402 Suggested Reading

- *Wastewater Collection Systems Management*, Chapter 4, pages 123 – 135; Chapter 8, pages 217 - 225.
- *Utility Management*, Lesson 1, pages 3 – 6.
- *Manage for Success*, Chapter 4, (All).



KSA 403

Weight: 5%

Manages the development and implementation of goals, objectives, and policies for the wastewater collection program.

KSA403 General Competencies

Wastewater Collection System Managers utilize a number of advanced supervisory techniques to develop an effective workforce. One of the most effective being a joint labor management type program with emphasis on improving maintenance efforts, reducing operational costs, improving facility reliability and ensuring effective communication at all levels. These programs require a great deal of patience and success is dependent upon good communication and conflict resolution skills to be practiced by everyone. Therefore a manager must be highly-skilled in these areas and be able to recognize when to intervene.

These skills are generally gained through college level courses, specialized training organizations and professional trade related agencies.

KSA403 Math Competencies

There are no specific math competencies for this KSA.

KSA403 Suggested Reading

- *Manage for Success*, Chapter 1, pages 11 – 17; Chapter 2 (All); Chapter 4, page 138.
- *Utility Management*, Lesson 2, page 22.
- *Effective Supervisory Practices*, Chapter 8 (All); Chapter 11, (All).

KSA 404

Weight: 5%

Directs and supports supervisors and staff to ensure high performance in a customer service-oriented work environment that encourages achieving desired goals and objectives.

KSA404 General Competencies

A manager is responsible to ensure that everyone practices excellent customer service skills. This requires the establishment of policies and procedures to govern customer service activities ranging from answering phone inquiries, investigating complaints to follow-ups on customer service requests. A manager must also represent an agency at meetings with elected or appointed officials, community



meetings, legal proceedings or media interviews.

The level of training is determined upon an individual agency's policies and practices, but should include advanced customer service training, advanced communication skills, basic media training and presentation skills. These skills are generally gained through college level courses, specialized training organizations and professional trade related agencies.

KSA404 Math Competencies

There are no specific math competencies for this KSA.

KSA404 Suggested Reading

- *Manage for Success*, Chapter 2, page 75 – 79; Chapter 13, pages 392 – 398.
- *Operation and Maintenance of Wastewater Collections Systems*, Volume 2, Chapter 12, pages 519 – 522.
- *Effective Supervisory Practices*, Chapter 17 (All).

KSA 405

Weight: 5%

Evaluates the performance of the wastewater collection system such as staffing levels, energy efficiency, material costs, sanitary sewer overflows (SSOs), and predictive/preventive maintenance programs.

KSA405 General Competencies

In order to determine the overall performance of a wastewater collection system a manager must perform a number of analyses and studies. These may include determinations on staff levels, energy costs, preparing studies and analyses pertaining to operation and maintenance problems to identify potential engineering improvements, determining the effectiveness of maintenance programs, analyzing Sanitary Sewer Overflow trends and developing performance targets for field staff.

KSA405 Math Competencies

Managers must have excellent mathematical skills and be able to perform calculations to determine percentages, electrical usage, electrical efficiency, hydraulic efficiency, perform calculations to determine standard deviations and other related calculations that are utilized in the development of graphs/charts. This knowledge is usually gained through advanced in-house training, college level courses and specialized training courses.



KSA405 Suggested Reading

- *Utility Management*, Lesson 1, pages 6 – 11.
- *Wastewater Collection Systems Management*, Chapter 3, pages 64 – 78; Chapter 4, pages 112 - 119.
- *Manage for Success*, Chapter 8, pages 273 – 274.
- *Mathematics for Collection System Operators – a Workshop Manual*, Section 12 (All).

KSA 406

Weight: 5%

Plans, directs, coordinates, prioritizes, and reviews the work plan for the wastewater collection system.

KSA406 General Competencies

A Collection System Manager must have the ability to plan, organize and direct the operation and maintenance programs for a wastewater collection system. In addition to those activities previously mentioned, a manager is responsible for both short and long range planning for all aspects of an organization, not just operation and maintenance.

This requires a manager to develop both an annual work plan and a 3-5 year strategic plan. This requires excellent computer, writing and analytical skills, which are developed through advanced in-house training or college level courses.

KSA406 Math Competencies

There are no specific math competencies for this KSA.

KSA406 Suggested Reading

- *Manage for Success*, Chapter 1, pages 11 – 16, Chapter 4, pages 135 – 140; Chapter 6, page 205.
- *Effective Supervisory Practices*, Chapter 5 (All).



KSA 407

Weight: 5%

Participates in hiring process, conducts performance evaluations, works with employees to achieve performance goals and objectives, implements disciplinary procedures, and conducts general labor relations activities.

KSA407 General Competencies

A major function of any manager is personnel related activities. These may include:

- staffing decisions.
- development of classification related materials.
- coaching and counseling of staff.
- conducting performance appraisals.
- administering a positive discipline program.
- developing positive relationships with labor organizations.

Therefore, a manager must have a good understanding of the policies and procedures governing personnel/labor related matters and possess excellent communication skills.

This knowledge is usually gained through advanced in-house training, college level courses, specialized training courses and professional trade related agencies.

KSA407 Math Competencies

There are no specific math competencies for this KSA.

KSA407 Suggested Reading

- *Effective Supervisory Practices*, Chapter 7 (All), Chapter 13, (All), Chapter 18 (All).
- *Utility Management*, Lesson 1, pages 13 – 17, 20 – 22.
- *Manage for Success*, Chapter 1, pages 37 – 40.



KSA 408

Weight: 3%

Develops, implements, oversees and makes recommendations for wastewater collection equipment selection and maintenance program.

KSA408 General Competencies

A wastewater collection system a manager must perform a number of analyses and studies. These may result in recommendations for new/replacement wastewater collection system equipment, fleet equipment or other support equipment.

This knowledge is usually gained through advanced in-house training, college level courses and specialized training courses.

KSA408 Math Competencies

Managers must have excellent mathematical skills and be able to perform calculations to determine:

- percentages
- electrical usage
- electrical efficiency
- hydraulic efficiency
- lifecycle costs

Managers must also be able to perform related calculations that are utilized in the development of graphs/charts.

KSA408 Suggested Reading

- *Manage for Success*, Chapter 9, page 292.
- *Utility Management*, Lesson 2, page 30 (9.2), page 47 (14.3).
- *Wastewater Collections Management*, Chapter 7 (All); Chapter 8, pages 177 – 180.



KSA 409

Weight: 5%

Ability to negotiate and resolve wastewater collection system operational issues that involve other utilities, agencies, private organizations, government entities and the general public to address complex or non-routine issues.

KSA409 General Competencies

An important part of a collection systems manager's role is the ability to interact with others, especially when the issue may be controversial. This requires that a manager possess not only excellent communication skills, but the ability to negotiate a settlement that is acceptable to all parties.

The level of training required includes advanced communication skills, basic negotiation skills, media training and presentation skills. These skills are generally gained through college level courses, specialized training organizations and professional trade related agencies.

KSA409 Math Competencies

There are no specific math competencies for this KSA.

KSA409 Suggested Reading

- *Management for Success*, Chapter 2 (All); pages 157 - 158.
- *Wastewater Collection Systems Management*, Chapter 5 (All).
- *Utility Management*, Lesson 2, page 23.
- *Safety and Health in Wastewater Systems*, Chapter 10 (All).
- *What Every Supervisor Should Know*, Chapter 15, page 350.

KSA 410

Weight: 5%

Provides responsible and complex technical support to upper management and prepares/presents staff reports including organizational studies.

KSA410 General Competencies

Managers must perform detailed oriented work that includes planning, tracking, coordination and analyses of all aspects of a wastewater collection system agency's overall operation. This work must be accurate and presented in a clear and concise manner that is easily understood by non-technical staff. Therefore managers must have excellent analytical skills, excellent written/verbal communication skills, good



computer skills, excellent presentation skills, good understanding of an agency's specific policies/ procedures and a good knowledge of laws/regulations governing their agency.

This knowledge is usually gained through advanced in-house training, college level courses, specialized training courses and professional trade related agencies.

KSA410 Math Competencies

There are no specific math competencies for this KSA.

KSA410 Suggested Reading

- *Effective Supervisory Practices*, Chapter 9 (All).
- *Manage for Success*, Chapter 1, pages 50 – 54; Chapter 2 (All) Chapter 8 (All).

KSA 411

Weight: 5%

Originates and administers the work of contractors/consultants/engineers for a variety of wastewater collection system construction and/or maintenance projects.

KSA411 General Competencies

Although the vast majority of wastewater collection system maintenance activities are performed in-house, a large percentage of capital improvements, extensive maintenance or larger construction projects must still be outsourced. This requires a collection system manager to:

- prepare studies and analyses pertaining to operation and maintenance problems to identify potential engineering improvements.
- evaluate long range financial and operational plans prior to initiating improvements and modifications.
- issue requests for proposals (RFPs).
- review proposals for alteration, modification or expansion of collection system facilities.
- review engineering plans, specifications, submittals and construction related documents.
- coordinate construction and maintenance activities.
- provide project management support on collection system projects.
- assist in preparation of Capital Improvement Project master plan and operating budget.

This knowledge is usually gained through advanced in-house training, college level courses, specialized training courses and professional trade related agencies.



KSA411 Math Competencies

There are no specific math competencies for this KSA.

KSA411 Suggested Reading

- *Manage for Success*, page 156 - 158.
- *Wastewater Collection Systems Management*, pages 34 – 35, pages 139 – 149.

KSA 412

Weight: 6%

Responsible for the development and administration of safety training programs for wastewater collection system staff; and ensures compliance with safe working practices, rules and regulations.

KSA412 General Competencies

A Wastewater Collection System Manager must be committed to ensuring that all employees have a safe workplace and that all work is performed in a manner that provides the highest level of safety for the protection of agency employees and the public. Therefore a manager has the ultimate responsibility for an Agency's Injury and Illness Protection Program (IIPP). This requires the establishment of safe work practices and procedures to prevent injuries, accidents, illness, property damage and hazardous substance releases to allow employees to perform their jobs in a safe manner.

A manager must have a good understanding of the rules/regulations governing wastewater operation and maintenance activities to ensure that all employees are properly trained for the tasks they perform. Additionally a manager must ensure all employees comply with established safe work practices, rules and regulations.

This knowledge is usually gained through advanced in-house training, specialized training courses and professional trade related agencies.

KSA412 Math Competencies

There are no specific math competencies for this KSA.

KSA412 Suggested Reading

- *Wastewater Collection Systems Management*, Chapter 1 (All).



- *Utility Management*, Lesson 2, pages 39 – 43.
- *Manage for Success*, Chapter 5 (All).
- *Safety and Health in Wastewater Systems*, Chapter 1 (All). Chapter 2 (All).
- *Wastewater Collection System Maintenance*, Chapter 1, (All).

KSA 413

Weight: 7%

Administers training to wastewater collection system staff in their areas of work such as but not limited to inspection and repair procedures, methods, and equipment.

KSA413 General Competencies

As mentioned in KSA Section 412, a Wastewater Collection System Manager must be committed to ensuring that all employees have a safe workplace and that all work is performed in a manner that provides the highest level of safety for the protection of agency employees and the public. Therefore a manager has the ultimate responsibility for ensuring that all employees are trained for all tasks they are expected to perform. This requires that a manager oversee the development of a comprehensive training program that prepares employees at all levels.

In addition, a manager should provide "promotional training" in support of employee development programs. There are a wide variety of skills required to develop of a training program, including excellent communication skills (verbal and written), labor relations, computer skills and knowledge of the rules/regulations governing wastewater operation and maintenance activities.

Managers usually gain these skills through advanced in-house training, specialized training courses and professional trade related agencies.

KSA413 Math Competencies

There are no specific math competencies for this KSA.

KSA413 Suggested Reading

- *Manage for Success*, Chapter 5 (All).
- *Wastewater Collection System Maintenance*, Chapter 4 (All), Chapter 11, (All), Chapter 14 (All), Chapter 15 (All).
- *Utility Management*, Lesson 1 5.52, pages 12 – 13.



KSA 414

Weight: 5%

Oversees and participates in the development and administration of the wastewater collection system annual budget; tracks and forecasts resources needed for staffing, equipment, materials, and supplies; monitors and approves expenditures and implements adjustments.

KSA414 General Competencies

All wastewater agencies have a fiduciary responsibility to their ratepayers and depending on the organizational structure a large portion of this responsibility may rest with a Collection System Manager. In many organizations a manager is responsible for:

- assisting in the preparation of collection system operating budget.
- performing detailed studies and analyses of wastewater operations to develop both short and long range financial/staffing plans.
- preparing/reviewing various purchasing documents.
- reviewing and establishing policies dealing with purchasing and monitor all expenditures including material and labor.
- assisting in the development of rate structures.

This knowledge is usually gained through advanced in-house training, college level courses, specialized training courses and professional trade related agencies.

KSA414 Math Competencies

There are no specific math competencies for this KSA.

KSA414 Suggested Reading

- *Manage for Success*, Chapter 9 (All).
- *Utility Management*, Chapter 9 (All).
- *Wastewater Collection Systems Management*, Chapter 8 (All).
- *What Every Supervisor Should Know*, Chapter 19 (All).



KSA 415

Weight: 5%

Initiates, develops and administers wastewater collection programs, policies, and procedures to ensure a safe, effective and efficient operating system.

KSA415 General Competencies

The successful operation of a wastewater agency is dependant upon a series of polices and proce- dures that govern all activities. This requires that a manager review and establish polices dealing with work practices, safety practices, training, purchasing and discipline. In addition a manager may review, develop and issue policy statements concerning collection system activities. Therefore a manager must have a good understanding of collection system activities, the rules/regulations governing per- sonnel/labor related matters, the rules/regulations governing employee safety and possess excellent communication skills.

This knowledge is usually gained through advanced in-house training, college level courses, special- ized training courses and professional trade related agencies.

KSA415 Math Competencies

There are no specific math competencies for this KSA.

KSA415 Suggested Reading

- *Utility Management*, Lesson 1 pages 11 – 22.
- *Manage for Success*, Chapter 1 (All).
- *What Every Supervisor Should Know*, Chapter 2, pages 63 - 87.



KSA 416

Weight: 4%

Attends and participates in professional group meetings; stays abreast of new trends and innovations in the field of wastewater collection system operation and maintenance; ensure the availability of opportunities for all staff to participate in professional development.

KSA416 General Competencies

All certified wastewater managers are required to participate in professional development opportunities in order to maintain their certification status. In addition these training opportunities provide valuable information to assist the professional manager in fulfilling multiple responsibilities, which includes providing professional development opportunities for others.

KSA416 Math Competencies

There are no specific math competencies for this KSA.

KSA416 Suggested Reading

- *Manage for Success*, Chapter 14 (All).
- *What Every Supervisor Should Know*, Part 8 (All).

KSA 417

Weight: 5%

Responds to difficult and sensitive public inquiries in a professional and courteous manner, and develops formal reports and responses to the media.

KSA417 General Competencies

While a manager is responsible to ensure that everyone practices excellent customer service skills, they should personally handle difficult situations and sensitive public inquiries. A manager must also represent an agency at meetings with elected or appointed officials, community meetings, legal proceedings or media interviews.

The level of training is determined upon an individual agency's policies and practices, but should include advanced customer service training, advanced communication skills, basic media training and



presentation skills. These skills are generally gained through college level courses, specialized training organizations and professional trade related agencies.

KSA417 Math Competencies

There are no specific math competencies for this KSA.

KSA417 Suggested Reading

- *Wastewater Collection Systems Management*, pages 131 – 137.
- *What Every Supervisor Should Know*, Chapter 15 (All).

KSA 418

Weight: 4%

Reviews and responds to liability claims and participates in the investigation of violations of employer policies or agency ordinances.

KSA418 General Competencies

A wastewater collection system in a complex utility that is subject to many liability claims including personal injuries, property damage, employment related claims and/or agency initiated litigation for violations of established ordinances. These issues usually require that a manager conduct an investigation and prepare some written correspondence related to the respective matter. Additionally the manager must be prepared to represent the agency at legal proceedings and have the ability to negotiate a settlement that is acceptable to all parties.

The level of training required includes advanced communication skills, basic negotiation skills and presentation skills. These skills are generally gained through college level courses, specialized training organizations and professional trade related agencies.

KSA418 Math Competencies

There are no specific math competencies for this KSA.

KSA418 Suggested Reading

- *Manage for Success*, Chapter 3, Page 124.
- *Utility Management*, Lesson 1, 5.56, page 20.



KSA 419

Weight: 5%

Oversees the process of containing and clean-up of spills emanating from the collection system and certifies documentation for sanitary sewer overflows.

KSA419 General Competencies

In January 2007 the California State Water Resources Control Board adopted Waste Discharge Requirements (WDRs) for all wastewater collection systems greater than one mile in length. The WDRs require that all agencies designate a Legally Responsible Official (LRO) who must certify all documents/reports related to the WDRs. This function is usually delegated to the Collection System Manager who must oversee all aspects of an agency's Sanitary Sewer Overflow Response and Reporting Program. The program should include specific policies and procedures related to SSO containment, alleviating a blockage, clean-up measures to be performed after an SSO and proper reporting/notification guidelines. In addition the LRO must complete an Annual Questionnaire regarding the Agency's wastewater system and oversee the Sewer System Management Plan.

These skills are generally gained through specialized training organizations and professional trade related agencies.

KSA419 Math Competencies

There are no specific math competencies for this KSA.

KSA419 Suggested Reading

- *Statewide General Waste Discharge Requirements for Sanitary Sewer Systems Order No. 2006-0003-DWQ* (All).
- *Wastewater Collection Systems Management*, Chapter 1, pages 16 – 18.
- *Utility Management*, Lesson 2 – 13, pages 33 – 34.
- *Manage for Success*, Chapter 11, (All).



Test Preparation

This section provides tips on how candidates should prepare, information provided with the test, the types of questions likely to be on the test, and solutions to typical math problems.

Basic Study Strategy

To prepare adequately, candidates need to employ discipline and develop good study habits. Ample time to prepare for the test should be allowed. Candidates should establish and maintain a study schedule. One or two nights a week for one or two months should be sufficient in most cases. Spend one or more hours studying in quiet surroundings or in small groups of two or three serious candidates. Efforts should be directed to the test subject areas that are not being performed on a day-to-day basis.

While using this study guide, be sure to understand the KSAs and answers to all questions. Discuss test questions with others. Not only is this a good study technique, it is also an excellent way to learn.

Candidates should study at the certification level being sought after. There is no advantage to spending time studying material that will not be on the test. Refer to Section 3 for a description of the KSAs and reading assignments that cover the topics on the test.

It is not necessary, but certainly helpful, to memorize all formulas and conversion factors. A formula table is provided on the test to assist in this area. Tables 4-1 give the same formulas and conversion factors as those given on the test.

Candidates should obtain the primary reference and training material listed in Section 6. Any material not available at their workplace can be obtained from the sources listed in Section 6.

Multiple Choice Questions

All test questions are written in multiple-choice format. At first glance, the multiple-choice problem may seem easy to solve because so much information is given, but that is where the problem lies. The best answer must be chosen from the information provided. Here are some tips that may help solve multiple-choice questions.

1. Read the question completely and closely to determine what is being asked.
2. Read all the choices before selecting an answer.
3. Look for key words or phrases that often, but not always, tip off correct or incorrect answers:



Table 4-1 Standard Measurements and Formulas	
12 inches = 1 foot	27 cubic feet = 1 cubic yard
36 inches = 3 feet = 1 yard	1 cubic foot of water = 7.48 gallons
5,280 feet = 1 mile	1 cubic foot of water = 62.4 pounds
1,440 minutes = 1 day = 24 hours	1 gallon of water = 8.34 pounds
144 square inches = 1 square foot	1 million gallons per day (MGD) = 694 gallons per minute
9 square feet = 1 square yard	1 million gallons per day (MGD) = 1.55 cubic feet per second (csf)
43,560 square feet = 1 acre	1 horse power = 0.746 kilowatts (kw)
1,728 cubic inches = 1 cubic foot	Slope = $\frac{\text{Rise}}{\text{Run}}$
Flow	
Q = AV	Q = Flow A = Area V = Velocity
Area	
Rectangle: A = LxW Circle: a = 0.785D ²	A = Area L = Length W = Width
Volume	
Rectangular Solid: Vol = LWd Right Regular Cylinder: Vol = 0.785D ² L or Vol = 3.14 R ² L	Vol = Volume L = Length W = Width d = Depth D = Diameter C = Circumference



Absolute Words

(Suspect as a wrong choice)

All	Never
Always	None
Totally	Completely

Limiting Words

(Often a correct choice)

Few	Occasionally
Some	Generally
Often	Usually
Many	Possible

4. Never make a choice based on the frequency of previous answers. If the last ten questions have not had a “b” answer, don’t arbitrarily select “b”. Instead use logic and reasoning to increase the chances of choosing the best answer.
5. Reject answers that are obviously incorrect and choose from the remaining answers. For example, in the multiple choice question, “Why are gasoline and volatile solvents objectionable when present in a sewer?”
 - a. They produce an explosion hazard.
 - b. They tend to cause solids to vaporize.
 - c. They will coagulate floatables and cause stoppages.
 - d. Because they float, the substances flow to plant headworks quicker.”

In reviewing physical and chemical characteristics of gasoline and volatile solvents, the specific gravities of these substances are generally less than water and float to the surface. They are solvents for other similar industrial organic chemicals. Therefore, answer “b”, that proposes gasoline and volatile solvents cause solids such as sand, and grit to vaporize, is obviously an incorrect answer.

6. Make an educated guess. Never reconsider a choice that has already been eliminated. That means in the example above, answer “b” is out.

Look for “key” phrases or words that give a clue to the right answer. For the example above, choices “c” and “d” discuss floatables and are potentially good answers. For answer “c”, chemical interaction of gasoline with floatables is not likely unless they are oil and grease. In such case, the solvent may disperse the oil and grease and reduce stoppages.

Answer “a” and “d” remain and are both reasonable choices. However, the best answer must be selected. Answer “d” is true, but without knowing the explosive nature of gasoline and volatile solvents, the answer is only a fact. An explosive material in wastewater creates a condition that endangers the public, a potential loss of expensive facilities, and a hazard to operations and maintenance personnel. The best answer is “a”, they produce an explosion hazard.

7. Skip over questions that are troublesome. Mark these questions for later review.



8. When finished with the test, return to the questions skipped. Now think! Make inferences. With a little thought and the information given, the correct answer can be reasoned out.
9. Under no circumstances leave any question unanswered. There is no penalty for an incorrect answer. However, credit is given only for correct answers.

NO ANSWER=WRONG ANSWER

10. Keep a steady pace. Check the time periodically.
11. Remember to read all questions carefully. They are not intended to be “trick questions”; however, the intent is to test a candidates’ knowledge of and ability to understand the written languages of this profession.

Math Problems

Math problems on the certification tests are meant to reflect the type of work encountered in Collection System Maintenance. Although there is no specific math section on the test, many questions will require some calculations such as area, volume, ratios, and conversion of units. Although math is important on the test, do not neglect other parts of the KSAs and focus too much time on the math. Completing the math problems will be greatly simplified by using a calculator and the approach suggested in the following paragraphs.

Calculators

Approved calculators may be used during the test. See the approved calculator list at www.cwea.org/cbt. A screen calculator will also be available on the test similar to the standard calculator found on computers running Windows. The most important factor in effectively using a calculator is the candidates’ familiarity with its use prior to the time of the examination. Confidence in the calculator and a full understanding of how to properly operate it are a must. The best way to gain confidence is to obtain a calculator from the approved calculator list and use it frequently.

Completing the worksheets in this section as well as the sample problems at the various grade levels will improve proficiency. Additional use will also help. For example, calculate the gas mileage when filling a vehicle’s tank each time. Check the sales tax calculation on each purchase. Balance a checkbook, or check a paycheck. The calculator chosen should have large enough keys so that the wrong keys are not accidentally punched. Be certain there are new batteries in the calculator, or use a solar powered calculator with battery back up.

Approach

The solution to any problem requires understanding of the information given, understanding of what is being requested, and proper application of the information along with the appropriate equations to obtain an answer. Any math problem can be organized as follows:

Given or Known. All information provided in the problem statement that will be used to get the correct answer.

Find. A description of the answer that is being requested.

Sketch. If possible, sketch the situation described in the problem statement showing size and shape (dimensions).



Equation. The equation or equations that will be used to generate the listed answers

Assumption(s). Stated assumptions of key information needed to answer a math problem with missing information. This occurs frequently on higher-grade tests.

Answer. This is where the answer is clearly identified.

Advantages to using this approach to organize math problems are that it helps to organize thoughts, breaks the problem solution into a series of smaller steps, reducing chances of making an error.

Solutions

Solutions to math problems are like driving routes from Los Angeles to San Francisco: there are many different routes that can be taken. Some routes are shorter or less complicated than others. Only certain routes end up in San Francisco.

Solutions to sample problems given in this study guide are the most common solutions. If a solution that is different, but arrives at the correct answer is found, then that solution can be used.

Equivalents/Formulas

A sample of the equivalents and formulas sheet from the examination is included in Table 4-1. Familiarity with each of the equivalents (conversion factors) and each of the formulas is important. Pay special attention to the units of measure that are used in the formulas. A correct answer will not be obtained unless the correct units of measure are used.

Check the units, arithmetic, and answer. So that:

1. The units agree.
2. The answer is the same when the arithmetic is repeated.
3. The answer is reasonable and makes sense.

Dimensional Analysis

When setting up an equation to solve a math problem, the trick is to have clearly in mind what units the answer should be in. Once the units have been determined, work backwards using the facts given and the conversion factors known or given. This is known as dimensional analysis, using conversion factors and units to derive the correct answer.

Remember, multiplying conversion factors can be likened to multiplying fractions. The denominator (the number on the bottom of the fraction) and the numerator (the number on the top of the fraction) cancel each other out if they are the same, leaving the units being sought after.

Example:

If a company runs a discharge pump rated at 50 gallons per minute all day, every day for a year, what is the discharge for the year in millions of gallons per year (MGY)?

Given: pump rating = $50 \frac{\text{gal}}{\text{min}}$



Find: discharge = ? MGY

Calculations: Convert gal/min to million gal/yr, convert gallons to million gallons, and minutes to years.

What is known about minutes and years? There are 60 minutes in an hour, 24 hours in a day, and 365 days in a year. Put that into an equation, and multiply each conversion factor so the unneeded units are cancelled out:

$$50 \frac{\text{gal}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \times 24 \frac{\text{hr}}{\text{day}} \times 365 \frac{\text{days}}{\text{yr}} \times$$

$$1 \frac{\text{MG}}{1,000,000 \text{ gal}} = 26.28 \text{ mgy}$$

Sample Questions

The following sample math problems are intended to demonstrate unit conversion techniques. Although they are general wastewater problems, the questions may not be specific to any vocation.

1. How many gallons of water will it take to fill a 3 cubic foot container?

$$3 \text{ cubic feet} \times 7.48 \frac{\text{gallons}}{\text{cubic foot}} = 22.4 \text{ gallons}$$

2. If a gallon of gasoline weighs 7.0 pounds, what would be the weight of a 350 gallon tank full of gasoline?

$$350 \text{ gallons} \times 7.0 \frac{\text{pounds}}{\text{gallon}} = 2,450 \text{ pounds}$$

3. The rated capacity of a pump is 500 gallons per minute (GPM). Convert this capacity to million gallons per day (MGD).

$$500 \text{ gpm} \times 1 \frac{\text{MGD}}{694 \text{ gpm}} = 0.72 \text{ MGD}$$

4. A chemical feed pump is calibrated to deliver 50 gallons per day (GPD). What is the calibrated chemical feed in gallons per minute (GPM)?

$$\frac{50 \text{ gal}}{\text{day}} \times \frac{1 \text{ day}}{24 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 0.035 \text{ GPM}$$

5. A chemical feed pump delivers 50 mL per minute (mL/min). Determine the chemical feed in gallons per day (gpd).



$$\frac{50 \cancel{\text{ mL}}}{\cancel{\text{ min}}} \times \frac{1 \cancel{\text{ L}}}{1000 \cancel{\text{ mL}}} \times \frac{1 \text{ gallon}}{3.785 \cancel{\text{ L}}} \times \frac{60 \cancel{\text{ min}}}{\cancel{\text{ hr}}} \times \frac{24 \cancel{\text{ hr}}}{\text{ day}}$$

$$= 19 \frac{\text{gallon}}{\text{day}} = 19 \text{ gpd}$$

6. A cyanide destruction process is designed to treat 30 pounds of cyanide per 24-hour operational day. How many pounds of cyanide can be treated during an 8- hour shift?

$$\frac{30 \text{ lbs CN}}{\cancel{\text{ day}}} \times \frac{8 \cancel{\text{ hr}}}{\text{ shift}} \times \frac{1 \cancel{\text{ day}}}{24 \cancel{\text{ hr}}} = \frac{10 \text{ lbs CN}}{\text{ shift}}$$

Math Skills

Successful candidates must be skilled in arithmetic and geometry. Candidates must be able to apply these skills to make calculations for work-related tasks such as excavation, stationing, pumping, determining flow rate, cost estimation, and any other job related math skill that may fall within the Skill Sets listed in Section 3. A thorough review of the types of mathematics required for the test is beyond the scope of this study guide. Consult an appropriate math text (see Section 6, References) if there is unfamiliarity with any of these specific math skills. Appendix A provides general strategies for approaching math problems, math anxiety, and resources for remedial study.

Arithmetic

Candidates should be able to perform and understand the following calculations either manually or with a calculator:

1. Addition and subtraction of whole numbers and fractions.
2. Multiplication and division of whole numbers and fractions.

Be prepared to apply these basic skills to work-related problems. The following example problem requires application of knowledge and application of basic arithmetic and the ability to convert units.

Example:

Determine the volume of a concrete slab that measure 150 feet long, 200 feet wide, and 3 inches thick. Express your answer in cubic yards.

First convert inches to feet:

$$3 \text{ inches} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 0.25 \text{ feet}$$

Next, using the formula for volume given in Table 4-2, determine the volume of the concrete slab in cubic feet:

$$\text{Vol} = \text{LWd}$$

$$\text{Vol} = 150 \text{ feet} \times 200 \text{ feet} \times 0.25 \text{ Feet}$$

$$\text{Vol} = 7,500 \text{ cubic feet}$$



Finally, calculate the volume of concrete in cubic yards:

$$7,500 \text{ cubic feet} \times \frac{1 \text{ cubic yard}}{27 \text{ cubic feet}}$$

$$= 277.78 \text{ cubic yards}$$

Geometry

Candidates should be able to calculate circumference, find the area of a rectangle, circle, and the volume of a rectangular solid or a right cylinder. This problem requires application of knowledge and application of basic geometry, arithmetic, and the ability to convert units.

Example:

What is the area of a manhole that measures 40 inches in diameter? Express your answer in square feet.

First convert inches into feet.

$$40 \text{ inches} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 3.33 \text{ feet}$$

Then calculate the area of the manhole using the formula for the area of a circle given in Table 4-2.

$$A = 0.785D^2$$

$$A = 0.785 \times 3.33 \text{ feet} \times 3.33 \text{ feet}$$

$$= 1,256 \text{ ft.}^2$$

Area of manhole

$$= 8.71 \text{ square feet}$$



Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter. The actual certification test is given on a computer at a secure testing site. The computer-based test (CBT) requires test takers to be able to use a computer mouse and some very basic keyboard functions. Candidates who have never taken a computerized test are strongly encouraged to try the online CBT demo to become familiar with the computerized test format before going to a test site. A CBT tutorial is also available to candidates just before they start their test. For more information about CBT and to try the CBT demo go to www.cwea.org/cbt.

The number of test questions on the actual certification test may range from about 90 to 130 questions (this practice test has over 130 questions). The time limit for the test is 3 hours. The computerized certification test can be paused for restroom breaks, but the 3-hour clock will not stop. A formula table very similar to Table 4-1 (Section 4) will be available as a window on the computer screen during the test. The format of the test questions on the computerized certification test is very similar to the multiple choice questions given in this practice test. There are no fill-in or essay type questions given on the test. Most questions on the certification test are worth 1 point, however some can be worth up to 5 or more points depending on the level of difficulty or calculations required. No point values are given for questions on this practice test so the weighting will not precisely reflect that of the actual certification test. If answered correctly, candidates will earn the number of points given for a question. If a question is not answered correctly, then no points are awarded (there is no penalty for "guessing"). At the test site, calculators are limited to a list of approved calculators. A screen calculator, similar to the basic Windows computer calculator, is also available during the test and can be toggled between basic and scientific modes. For the list of allowable calculators see the Calculator Policy at www.cwea.org/cbt, or contact CWEA at 510-382-7800, or tcp@cwea.org.

The practice test includes a key after the end of the test. Some question that require calculations include solutions that are given after the key. These are indicated on the key with "see solutions" to the right of the correct answer. Candidates are encouraged to find the solutions to all of the questions requiring calculations themselves.



Practice Test

Select the best answer for each item below.

1. A supervisor could be responsible for an accident, in part or completely by:
 - a. providing an unsafe work environment.
 - b. requiring work to be performed.
 - c. eliminating a potential hazard.
 - d. providing the appropriate training and tools.

2. What are the basic elements of a safety program?
 - a. Accident investigation, injury frequency rates, safety policy statement
 - b. Injury frequency rates, safety policy statement, safety training
 - c. Lost time accident statistics, injury frequency rates, accident investigation
 - d. Safety policy statement, safety training, accident investigation

3. Who develops Material Safety Data Sheets?
 - a. Management
 - b. Manufacturer
 - c. Salesman
 - d. Safety officer

4. Responsibilities of supervisors and managers for a safety program include:
 - a. not providing a written safety policy.
 - b. never provide safety training.
 - c. identify and correct unsafe work practices.
 - d. never investigate accidents.

5. What is the intent of the OSHA regulations?
 - a. To provide adequate staffing
 - b. To put managers in jail
 - c. To provide a safe work environment
 - d. To provide a safe home environment

6. Which of the following is an infectious disease?
 - a. Asphyxiation
 - b. Contusions
 - c. Hypothermia
 - d. Typhoid



7. Records are essential for effective utility management and to satisfy legal requirements. Records should be:
- accurate, pertinent, and complete
 - specific, detailed, and redundant
 - concise, processed and general
 - legal, effective, and functional
8. How closely an instrument measures the actual value of the process variable being measured is called its:
- accuracy.
 - calibration.
 - precision.
 - standardization.
9. What is a vibrating roller primarily used for?
- Asphalt paving
 - Pipe laying
 - Line cleaning
 - Land scraping
10. As the Division Manager you receive a sensitive request for information from the media you should:
- delegate this request to a subordinate.
 - avoid answering any questions.
 - handle the request personally.
 - state repeatedly "I have no comment at this time."
11. High velocity cleaning machines use which of the following to clean sewer mains?
- High water pressure
 - Low water pressure
 - High steam pressure
 - Low steam pressure
12. What is needed to keep cleaning equipment in good repair?
- Tolerance, temper, tools
 - Talent, temper, tools
 - Talent, time, tools
 - Tolerance, time, tools



13. What is the calibration standard used for gas detection meters used in wastewater collection system operations?
- Petro-chemical
 - Public works above ground
 - Public safety/HazMat
 - Public works underground
14. An important aspect of communication when negotiating with other entities that have different interest and concerns than those of your utility is:
- Know your audience.
 - Remove non-essential points.
 - Stay on topic.
 - How can I make it interesting.
15. Sources of excessive clear water in a collection system include:
- a problem at the wastewater treatment plant.
 - a water distribution main construction project.
 - evaporation.
 - infiltration from a high water table.
16. As the Division Manager you receive a request from your Board or Council and they want an immediate response. You do not know all the answers. You should:
- wait until you have the answer and respond.
 - respond with the information available and update them with more.
 - tell them what you think they need to hear.
 - respond with all the answers and results that you think are important .
17. Closed circuit television in collection systems are used to evaluate:
- effectiveness sewer cleaning and clearing techniques.
 - effectiveness of budget cuts.
 - effectiveness of pumping cycles.
 - effectiveness of safety programs.
18. A pump must pump 1,500 gpm against a total head of 40 feet. What horsepower is required?
- 14.5 hp
 - 15.2 hp
 - 15.5 hp
 - 16.3 hp



19. As a utility manager you may be requested by the media to be interviewed about a breaking news story. When speaking to the media, which of the following should you avoid?
- Speaking in personal terms, free of institutional jargon
 - Arguing and showing anger if the reporter appears to be rude or aggressive
 - Answering "I don't know, but I'll find out" if you are unsure of the correct response
 - Stating your key points early in the interview
20. If a 35-hp pump is running at 85%, what is the brake horsepower required?
- 39.3 hp
 - 39.8 hp
 - 40.2 hp
 - 41.2 hp
21. What is the power cost of a 75-hp pump if the pump runs 144 hours with a power cost of \$0.06125/kWh for one week?
- \$493.04
 - \$494.50
 - \$523.17
 - \$525.00
22. For one week the following flows were recorded daily: 4.6 mgd, 5.2 mgd, 5.3 mgd, 4.9 mgd, 5.4 mgd, 5.1 mgd, 4.8 mgd. What was the average daily flow for the week?
- 5.3 mgd
 - 4.3 mgd
 - 4 mgd
 - 5 mgd
23. The following flows were recorded for the months of June, July, and August: June 125.6 MG; July 142.4 MG; August 160.2 MG. What was the average daily flow for this three month period?
- 4.65 MGD
 - 4.69 MGD
 - 4.72 MGD
 - 4.85 MGD
24. If the sewer rate is \$5.50 for the first 500 cubic feet and all use over the minimum is billed at the rate of 25 cents per 100 cubic feet, how much would a customer discharging 1,200 cubic feet be billed?
- \$5.25
 - \$6.25
 - \$6.75
 - \$7.25



25. What should be the most important concern of an operator after a SSO?
- Aquatic life
 - Clean-up procedures
 - Health-related effects
 - Odors
26. What is Outsource Contracting?
- Contracting for services through another firm or agency.
 - Retaining an individual or firm from outside the utility to perform tasks of the Utility.
 - Contracting with an individual or firm when there are no other alternatives.
 - Retaining a service to perform routine work outside your agencies area of expertise.
27. “_____and requires more preparation, organization and tends to be more formal.”
- Which of the following best completes this statement?
- Written communication is more demanding than oral communication.
 - Passive communication is more demanding than active communication.
 - Visual communication is more demanding than physical communication.
 - Verbal communication is more demanding than auditory communication.
28. Your system’s billing is based on the water usage rate. If your system bills quarterly at a rate of 50 cents/1,000 gallons for the first 10,000 gallons, \$0.41/1,000 for the next 15,000 gallons and \$0.25/1,000 for all over 25,000 gallons. If a customer uses 35,000 gallons per quarter, what is the bill?
- \$11.00
 - \$13.65
 - \$21.75
 - \$27.15
29. You have a centrifugal pump that delivers 400 gpm against a head of 200 feet with a combined pump and motor efficiency of 70%. What is the cost for electrical power for operating the pump 12 hours/day for three months of 31 days each? (The electrical cost is 5 cents per kilowatt hour and 1 horsepower = 0.746 kilowatt.)
- \$1281
 - \$1842
 - \$1214
 - \$1682



30. If a flow of 750 gpm is entering a wet well that is 50 feet long by 20 feet wide by 12 feet deep, what is the average detention time?
- a. 60 minutes
 - b. 80 minutes
 - c. 100 minutes
 - d. 120 minutes
31. What chemical is frequently used to control hydrogen sulfide?
- a. Sodium hypochlorite.
 - b. Potassium iodide with sodium sulfide.
 - c. Sodium sulfate.
 - d. Trinitrotoluene.
32. Vibration Monitoring for rotating machinery, Oil Analysis that detects residual metal particles and Thermography, are examples of techniques used in a:
- a. Preventative Maintenance Program.
 - b. Predictive Maintenance Program.
 - c. Reactive Maintenance Program.
 - d. Reliability Center Maintenance Program.
33. In selecting pipe material for maximum service life, which factor is most important?
- a. Ease of installation.
 - b. Initial cost.
 - c. Life expectancy of pipe.
 - d. Local manufacturer.
34. How can infiltration into the existing wastewater collection system be reduced?
- a. Enforcing ordinances that require roof drains to be discharged to sanitary sewer system
 - b. Inserting plastic liners into sewer pipes
 - c. Replacing no hole manhole covers with multi holed covers
 - d. Schedule cleaning operation during peak flow hours
35. When using a power rodding machine, why must the location of the clearing tool be known at all times?
- a. So there is enough rod left over if it breaks.
 - b. So the operator knows where to place the debris trap.
 - c. So the operator will know where to dig to recover the tool if it becomes stuck.
 - d. So the operator will know where to place the leader tool if the rod becomes coiled.



36. What is a sand or debris trap used for?
- To catch vermin.
 - To retard flow in a downstream manhole.
 - Instead of shoveling debris when hydrogen sulfide gas is a problem in the manhole.
 - To trap material worked loose during cleaning operations.
37. The current (2) pumps in your Duplex Lift Station have 40 HP motors and are 75% efficient. You intend to replace them with new pumps that are the same horsepower, but are 90% efficient. How much can you expect to save in electrical costs per month with the new pumps?
- Assume:
- One month = 30 Days
 - Each pump runs 12 hours per day average
 - Electricity costs 3.7 cents per kw hour
 - Round answer to nearest dollar
- \$88.00
 - \$177.00
 - \$129.00
 - \$99.00
38. Collection system operators need to know how engineers design collection systems so they can:
- design large, permanent collection systems.
 - perform design calculations for the engineers.
 - discuss the design with the engineers.
 - determine peaking factors for the engineers.
39. A good way to handle conflict in your department is to be:
- forceful, do not negotiate, and end it quickly.
 - fair and equal, always compromise, and try to please all parties.
 - Alert to its presence, seek out its causes, and meet it head-on.
 - passive in your approach, do not rub those involve the wrong way, and smile.
40. Results obtained from pipe roughness coefficient tests can indicate whether or not:
- contamination is entering a pipe.
 - the ability of the pipe to transmit if flow is being hindered.
 - the quality of the wastewater in the pipe is deteriorating.
 - the size and number of leaks are increasing.



41. What affects the flow capacity of a sewer line?
- Backfill material, manhole spacing, pipe size.
 - Burial depth, size, manhole spacing.
 - Pipe material, manhole rim elevation, pipe size.
 - Pipe size, pipe material, grade.
42. You are at a community meeting and a resident brings up an issue unrelated in any way to the topic you are there for. You should:
- tell the resident that you are not here for that and will not answer it.
 - spend the rest of the meeting addressing their issue.
 - tell them what you think they want to hear in order to move on.
 - try to answer the question quickly then move back to the topic.
43. Which of the following types of information should be recorded during TV inspection of a sewer?
- Amount of material removed in cubic feet
 - Distance from manhole to recorded observations
 - Volume of water used
 - Tools used
44. A resident complains that the sewer line has a problem. You do not know the answer. It would be best for you to do which of the following?
- Tell the person what you think they want to hear.
 - Refer the person to your supervisor.
 - Say that you are not allowed to give out that information to the public.
 - Inform the person that you don't know but will check in the problem.
45. A person approaches you and tells you of many complaints he has about your department. You should first:
- assume that his is just blowing off steam and ignore his complaints.
 - check into the legitimacy of the complaints.
 - ask for advice from your supervisor on the best way to handle the person.
 - regard the complaints as accurate and take immediate steps to correct them.



46. Although it is very important, safety is not the only benefit of a training certification program. Other benefits include:
- Helps to establish performance evaluation and disciplinary criteria.
 - Increases compensation for field staff and management.
 - Allows employees time away from the daily routine and improves moral.
 - Protection of the public's investment in utility facilities and employee pride and recognition.
47. Which of these chemicals should be used for odor control in sewers?
- Ferric chloride
 - Muriatic acid
 - Potassium chloride
 - Sodium chloride
48. Yokes, rollers, jacks, swivels, pull in machine, and loader are accessories used in:
- catch basin cleaning.
 - jet rodding.
 - power-bucket machine cleaning.
 - power rodding.
49. A sewer-use ordinance should specify the personnel performing:
- cleaning of the main lines.
 - monitoring.
 - repairing of broken pipes.
 - sealing of leaky joints.
50. What factor must be considered when obtaining an easement for construction and maintenance of a collection system?
- Compaction
 - Deposition of cut materials
 - Access for equipment and personnel
 - Manhole headroom
51. Sewer maps should be kept up-to-date for several reasons. Which of the following is the least appropriate reason?
- so a TV inspection program can be planned and scheduled effectively
 - so that census canvassers can determine data on standards of living
 - so that new house services can be connected with minimum difficulty
 - to permit development of better plans and specifications for street improvement projects



52. Some advantages of outsourcing some of your maintenance/repair work are:
- availability of Expertise, Technology and Resources; Flexibility to increase/decrease level of effort in response to changing situations; Capability to change contractors at end of contract term.
 - always less expensive than using your own forces; ease of contract administration; and typically the work is completed sooner.
 - it will motivate your own crews to improve performance; Improves your agency's moral; and keeps expenses down.
 - little staff time is required to monitor performance; Contracting for services has little risk for the agency; and your customers feel better seeing professionals doing the work.
53. When answering inquiries from the media, elected officials, or the public your answers should be:
- quick, short, and simple.
 - timely, simple, and aloof.
 - accurate, timely and concise.
 - None of the above.
54. A flat sewer line grade can cause sewer maintenance problems. The most likely cause is:
- increase in velocity allowing inorganic and organic solids to settle out.
 - decrease in velocity allowing organic and inorganic solids to settle out.
 - decrease in velocity allowing gasses to be released.
 - decrease in velocity allowing an increase in dissolved oxygen.
55. How many feet will a six inch sewer drop in 315 feet with a slope of 0.7%?
- 1.16 feet
 - 1.27 feet
 - 1.89 feet
 - 2.20 feet
56. Customers who complain:
- typically had unhappy childhoods.
 - usually just want the attention.
 - have had a bad experience with your agency in the past.
 - are doing you a service in identifying what isn't working in your business or organization.



57. The Federal law that requires all public agencies to permit eligible employees to take up to 12 weeks of time off in a 12-month period for Serious health issues; to care for a child after birth; or to care for the employee's spouse, child, or parent with a serious health condition is known as:
- The Health and Hazard Leave Act.
 - The Employer/Employee Leave Agreement.
 - The Family and Medical Leave Act.
 - The Americans with Disabilities Act.
58. The reason for digging bell holes when laying pipe is to:
- provide even bearing between the joints.
 - provide non-even bearing between the joints.
 - provide a place to test sand bedding compaction.
 - provide a mark to check pipe grade.
59. Construction defects that cause problems in wastewater collection systems include:
- proper grade of sewers.
 - improper taps.
 - watertight manholes.
 - sand backfill of pipe trench.
60. SSO is an acronym for:
- Sanitary Sewer Outfall
 - Storm Sewer Outfall
 - Sanitary Storm Overflow
 - Sanitary Sewer Overflow
61. In order to be a good negotiator you need to:
- put your needs first
 - give in at the first challenge
 - take good notes
 - look at the situation from both sides
62. Why would a utility manager develop and implement predictive maintenance programs?
- To reduce maintenance costs and downtime.
 - To prevent regulators from issuing notices of violations.
 - To determine future equipment needs.
 - To keep up with current industry trends.



63. Dealing with employee discipline requires tact and skill. Each manager has his or her own style, and all should attempt to stay:
- Stable, forceful and demanding.
 - Rigid, unyielding and concise.
 - Flexible, calm and open-minded.
 - Easy, co-dependent and forgiving.
64. A condition which can cause cavitation in a pump is:
- air leak on suction side.
 - clear water being pumped.
 - fully opened suction valve.
 - operating within design curve.
65. Mechanical ventilation of a lift station is required to:
- lower temperatures to reduce proportion of hydrogen sulfide.
 - reduce chlorine demand.
 - reduce corrosion.
 - Increase DO in raw wastewater.
66. "Hz" symbol stands for:
- Cycles per second
 - Hand control
 - Horizontal phase
 - Polyphase
67. If a three-phase, 220-volt electric motor has just been reinstaled after it has been rewound, and it starts to run in the wrong direction, what corrective action should you take?
- Change the ground wire.
 - Check the motor starter.
 - Reverse the connection of any two motor leads.
 - Send it back to the motor repair shop to be properly rewound.
68. What would be considered an acceptable standby system during power outage at a wastewater lift station?
- Wind mill.
 - Hand pump.
 - Utility power source.
 - Generator.



69. It is difficult to know what another's perception is. A good way to determine if someone understands what you are trying to convey or do is to:
- tell them twice so it will be clear.
 - ask for feedback.
 - ask if they understand.
 - just let it go if you feel you were clear.
70. A wet well design is too large for the flow, causing odors, what would correct this condition?
- Increase wet well pump start point.
 - Decrease pumping time.
 - Place "spacer" on bottom of wet well reducing wet well volume.
 - A larger pumping capacity.
71. Which of the following is a part of an electric motor?
- Impeller
 - Rotor
 - Sleeve
 - Volute
72. As the impeller wears on a pump, the pump efficiency will:
- decrease.
 - improve.
 - increase.
 - not change.
73. The most widely used type of prime mover in a wastewater lift station is:
- diesel engine.
 - electric motor.
 - gas engine.
 - steam engine.
74. When considering employees for promotion always:
- Promote the person with the most seniority.
 - Make promotions based on what is best for the performance of the utility.
 - Promote the most motivated employee.
 - Let them know in advance that they are on the "short-list."



75. What are the basic ways for a utility to finance capital improvements?
- General obligation bonds, loan funding programs, revenue bonds
 - Hook-up fees, loan funding programs, revenue bonds
 - Loan funding programs, revenue bonds, user service charges
 - General obligation bonds, loan funding programs, revenue bonds
76. Successful communication requires mutual:
- agreement.
 - confusion.
 - transmission.
 - understanding.
77. When a great deal of authority is delegated on many levels, an organization may be described as:
- authoritarian.
 - centralized.
 - decentralized.
 - unstructured.
78. Recognition and job security are indications of:
- a good organization.
 - a good supervisor.
 - external morale factors.
 - internal morale factors.
79. The first step to problem solving is:
- Realize the problem exists.
 - Gather the facts.
 - Analyze the problem.
 - Generate possible solutions.
80. Generally, as an individual progresses upward in management, reliance on personal technical skill:
- changes to the more complex.
 - decreases.
 - increases.
 - remains the same.
81. Special parts that should be carried in the inventory are usually listed in the:
- blue print.
 - history record.
 - manufacturer's manual.
 - work order.



82. How can the supervisor be certain that scheduled maintenance is completed?
- Ask the workers.
 - Hire someone to inspect completed work.
 - Use a form that compares work assigned with work completed.
 - Wait and see if there are any failures.
83. The State Water Resources Control Board Order No. 2006-003-DWQ established the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems. This requirement affects all owner or operators of sanitary sewer systems:
- Greater than 100 miles in length.
 - Greater than 1 mile in length.
 - That are satellite systems.
 - That are wastewater treatment systems.
84. Word has just come down from the upper management that operating funds are being cut. How should this be handled?
- Cut the supplies and repairs in order to balance the budget
 - Fire some of the less productive old employees
 - Keep it quiet and do what you have to do - the less said the better
 - Let the other personnel know what the situation is and ask for their help
85. One opening has become available which would be advancement to any one of three qualified employees. How should this situation be handled?
- Hire an outsider to fill the position
 - Pick one and notify all personnel of the change
 - Split the work between the three and leave the position open
 - Talk to the three as a group, explain the situation and make your selection, then notify all personnel of the change
86. The most important, of the items listed below, to pay attention to when meeting with others is:
- The slideshow at the meeting.
 - The amount of time each person speaks.
 - Body Language, Hand gesture and facial expressions.
 - The clock to ensure the meeting ends on time.
87. One of the employees in your crew complains about having to do a hard job. The proper thing to do is:
- explain that all employees must do their fair share of the hard work as well as the easier tasks.
 - ignore the complaint.
 - promise that the next assignments will be easier ones.
 - tell the employee to shut up and work or quit and go home.



88. Occasionally some of the people on a work crew will indulge in active horseplay. This should be:
- discouraged because some of the workers might not like it.
 - encouraged because it promotes good fellowship.
 - permitted as it is a form of relaxation.
 - stopped immediately because it is likely to cause an accident.
89. Sanitary sewer overflow (SSO) is defined as:
- Any, overflow, spill, release, discharge or diversion of untreated or partially treated wastewater from a sanitary sewer system.
 - Any, overflow, spill, release, discharge or diversion of untreated or partially treated wastewater from a sanitary sewer system in excess of one gallon.
 - Any, overflow, spill, release, discharge or diversion of untreated or partially treated wastewater from a sanitary sewer system in excess of 100 gallons.
 - Any, overflow, spill, release, discharge or diversion of untreated or partially treated wastewater from a sanitary sewer system in excess of 1000 gallons.
90. The managerial function which involves devising an appropriate system of pay is:
- controlling.
 - organizing.
 - planning.
 - staffing.
91. For utility records and/or rate analyses purposes, customers with similar patterns of water use are usually grouped together into what classes?
- Commercial, domestic, retail
 - Domestic, retail, industrial
 - Industrial, domestic, rental
 - Commercial, domestic, industrial
92. The span of supervision is the:
- average length of time required to be in the organization before making supervisor.
 - number of levels between the lowest employee and the boss.
 - number of subordinates for each manager.
 - number of supervisors in an organization.
93. If an organization's departments are organized by jobs to be done, this is known as departmentation by:
- customer.
 - function.
 - product.
 - territory.



94. Decentralized authority describes the process of:
- changing an organization from centralized to decentralized again.
 - delegating authority to one's superiors instead of one's subordinates.
 - delegating power for decisions to lower levels.
 - retracting authority, which has been previously delegated, and probably changing functions and duties.
95. What term means that the employee reports to one specific supervisor, and that the delegation of authority comes from one particular supervisor to the employee?
- Unity of command
 - Span of supervision
 - Organizational chart
 - Formal organization
96. In order to accurately estimate the volume of a sanitary sewer overflow (SSO) you must have:
- Spill Start Time, Spill End Time and Spill Rate.
 - Spill Rate, Spill Location, Spill Source.
 - Spill Duration, Surface Type, Spill Source.
 - Spill Start Time, Spill End Time, Surface Type.
97. It is generally accepted by psychologists that human behavior is goal-oriented and:
- selfish.
 - random.
 - other-centered.
 - motivated.
98. The term "Control", in management practices is:
- backward looking.
 - concentrating on the present.
 - forward looking.
 - not connected to the other managerial functions.
99. Dealing with grievances as quickly as possible:
- always resolves the issue in a timely manner.
 - often prevents small problems from growing into large problems.
 - helps a manager complete scheduled tasks on time.
 - complicates the discipline process.



100. When purchased materials are first received, they should be:
- inspected, counted, and checked against POs.
 - just sign for and ship out to field crews.
 - placed on shelves where they will be used first.
 - inspected, counted, and checked against MSDS.
101. In the steps of the decision making process, which step utilizes outside influences, such as experience, the most?
- Analyzing the problem
 - Defining the problem
 - Developing alternatives
 - Selecting an alternative
102. Training for supervisors is different than training for maintenance workers because Supervisors:
- Need to communicate effectively, motivate, and delegate responsibilities.
 - Have already had the training of the maintenance worker.
 - Don't perform the same work as the maintenance worker.
 - Need to maintain a "wall" between themselves and the maintenance worker.
103. Attending a Managers' retreat, reading texts that focus on management and leadership, and attending and/or participating in industry specific seminars/conferences are examples of:
- Leisure time away from work.
 - Professional development.
 - Manager's professional code.
 - Management productivity exercises.
104. If you were supervisor of two lead workers, one whose work was exceptionally good and a second whose work was substandard, what should you do?
- Demote the substandard foreman and bring up a replacement from the ranks
 - Discuss the problem with the substandard foreman and offer to help before any other action is taken
 - Find a replacement and then fire the substandard foreman
 - Wait to see if the substandard foreman does better.
105. Which of the following items is not to be considered in the budget for a Collection System?
- Anticipated costs due to labor and maintenance
 - Anticipated revenues
 - Insurance
 - Costs of street maintenance



106. Collection system maintenance programs include:
- emergency maintenance.
 - operation maintenance.
 - public maintenance.
 - media maintenance.
107. Providing a plan and schedule to properly manage, operate and maintain all parts of the sanitary sewer system is the goal of:
- a Sanitary Sewer Overflow Response Plan.
 - an Emergency Response Plan.
 - a Sewer System Management Plan.
 - a Sanitary Sewer Management Plan.
108. Recruiting of new employees falls within which category?
- Directing
 - Organizing
 - Planning
 - Staffing
109. In record keeping:
- every maintenance record should be included in an annual report.
 - poor records are better than no records.
 - records should be destroyed every two years.
 - records should be kept up to date and maintained as long as they are useful.
110. The managerial function, which includes the guiding, teaching, motivating and supervising of Collection system operators is:
- staffing.
 - planning.
 - organizing.
 - directing.
111. A good manager understands that no one player on a team is more important than another. This can be demonstrated by:
- Treating all of staff as professionals.
 - Informing all staff in a group meeting.
 - Acknowledging a job well done.
 - Offering constructive criticism at opportune times.



112. "Essence of control" is:
- written records.
 - testing.
 - evaluation.
 - action.
113. In the evaluation of an applicant for employment, which of the following may enter into your decision?
- Age
 - Education level
 - Minority classification
 - All of the above
114. The best way to record all maintenance work is done through:
- closed circuit TV.
 - Polaroid system.
 - tape recorder.
 - work order system.
115. Customers who complain want:
- Something for nothing.
 - To be heard and have their experience validated.
 - To vent for the sport of it.
 - To be made majority shareholders in the company.
116. Why are good records important?
- Demonstrate pattern of lawful behavior over a period of time
 - To polish your report-writing skills
 - Record all uncritical events
 - Give bookkeepers a job
117. What is the term "paper screening" meaning?
- Additional analysis of qualified applicants
 - Elimination of applicants not qualified for the job
 - Filing of unsuccessful applicants' paperwork for future job openings
 - Review of research papers submitted by a job applicant
118. Which one of the following questions is an acceptable interview question?
- What is your religious leader?
 - What is the nationality of your parents or spouse?
 - What is your age?
 - What is your technical background?



119. What is the best way a utility manager can assess the effectiveness of a training Program?
- Job observations.
 - Attendance records.
 - Impact on the budget.
 - Employee feedback.
120. What is the best approach to solve a discipline problem?
- Accept the employee's solution to the problem
 - Form a committee of peers to make a recommendation
 - Ignore the problem and it will go away
 - State the problem and then ask employee to suggest a solution
121. Why is written communication more demanding than oral communication?
- Ideas must be expressed clearly
 - Important information may be missed
 - Need to use highly technical terms
 - No chance to clarify and explain ideas in response to audience
122. What is a vulnerability assessment?
- Determination of value of utility
 - Development of an emergency response plan
 - Estimation of damages for most probable emergency situations
 - Review of spare parts inventory
123. What are the normal challenges that a manager faces from within a collection system organization?
- Equipment needs, resource allocation, local community demands
 - Local community demands, monitoring from regulatory agencies
 - Personnel requirements, equipment needs, resource allocation
 - Resource allocation, local community demands, monitoring from regulatory agencies
124. Training must be provided to new employees as well as ongoing training to all employees. Support for training programs should come from:
- Internal experts.
 - External consultants.
 - Training staff.
 - Top management on down.



125. What kinds of behavior are considered sexual harassment?
- Humiliating, Offensive, Invited, Hostile, Annoying
 - Annoying, Hostile, Humiliating, Offensive, Invited.
 - Inoffensive, Annoying, Hostile, Humiliating, Uninvited.
 - Annoying, Hostile, Humiliating, Offensive and Uninvited.
126. Scientific decision making tends to refer to:
- using computer techniques on quantifiable information.
 - problem solving in particular order.
 - experimentation.
 - consulting a scientist.
127. A good public relations program will include:
- vague and hard to understand billing.
 - discourage consumer complaints.
 - prompt response to consumer complaints.
 - referring all complaints to lawyers.
128. The utility manager deals with stress on many levels. There are ways to relieve work-related stress. Some of the proven ways a manager can reduce stress is:
- Close your office door when you aren't up to dealing with people; take frequent vacations; and implement a 'flex-schedule.'
 - Delegate tasks that cause you stress; understand that disappointing others is just art of the job; and disregard complaints from subordinates.
 - Don't fight losing battles; Take criticism with a grain of salt; and understand that you can't please everybody.
 - Stand strong and never admit when you are wrong; place a 'complaint' box outside your office where your staff can place their written complaints; and make it clear that you have more important duties running the department.
129. For large and/or complex projects, to help save time and effort when reviewing proposals and to save contractor's time when preparing proposals, it is a good idea to require:
- Request for Proposals (RFP).
 - Request for Information (RFI).
 - Request for Solutions (RFS).
 - Request for Qualifications (RFQ).



130. Getting the facts is the first step in what part of the process?
- Development of alternatives
 - Problem analysis
 - Problem definition
 - Selection of alternatives
131. When an employee breaks the rules and requires discipline, who is responsible for administering it?
- Fellow employees.
 - Personnel office
 - Supervisor
 - Upper management
132. An employee's goals and planned output needs to be outlined in which terms?
- Assignable and specific.
 - Time-bound and general.
 - Measurable and realistic.
 - Detailed and organized.
133. How can the supervisor be certain that scheduled maintenance is completed?
- Ask the workers.
 - Hire someone to inspect the completed work.
 - Inspect the work.
 - Wait and see if there are any failures.
134. A purchase order system effectively used provides what?
- An accurate and accessible record of purchases.
 - Data processing printouts of all purchases.
 - For compliance with the uniform system of accountants.
 - None of the above.
135. Which term describes the calculated amount by which the value of a collection system physical property declines annually due to wear and tear?
- Depreciation.
 - Rate base.
 - Rate of return.
 - Return on equity.



136. What must a manager have to prepare a budget?
- Sufficient revenues
 - Good records from previous year
 - Budget surplus
 - Good public relations
137. All discharges of sewage resulting from a failure in the sanitary sewer system that equal or exceed 1000 gallons; discharge into a drainage channel and/or surface water; or discharge to a storm drainpipe that was not fully captured and returned to the sanitary system is:
- Category 2 Spill.
 - Category 1 Spill.
 - Type 2 Sewage Release.
 - Private Lateral Spill.
138. An information management system helps utility managers make decisions by:
- collecting, analyzing, exchanging, storing, and delivering information.
 - collecting, analyzing, exchanging, deleting, and delivering information.
 - dispersing, analyzing, exchanging, deleting, and delivering information
 - collecting, mixing up, exchanging, deleting, and delivering information
139. What are functions of a manager?
- Planning, threading, staffing, directing, and controlling
 - Planning, organizing, staffing, building, and controlling
 - Padding, organizing, staffing, directing, and controlling
 - Planning, organizing, staffing, directing, and controlling
140. The three basic ways for a utility to finance a capital improvement program are:
- general private bonds, revenue bonds and loans.
 - planning, organizing, staffing, directing, and controlling.
 - general obligation bonds, debit bonds and loans.
 - general obligation bonds, debit bonds and gifts.
141. Customer Service Culture is:
- A new form of yogurt where the lid removes itself for you.
 - Behavior being analyzed in a Petrie dish for contagions.
 - A mythical civilization in which everyone smiles and welcomes you when they meet.
 - An environment where customer service permeates the thinking of the entire company.



142. A bypass operation is required to complete a repair on an 18-inch pipe, flowing full, that has a velocity of 2.5 fps. To maintain flows, your pump must have a minimum output (in GPM) of:
- 2,080 GPM
 - 1,440 GPM
 - 1,981 GPM
 - 3,066 GPM
143. What is the corporate culture of a utility?
- The organization chart of a utility.
 - The participation of staff in cultural activities.
 - The shared values and beliefs within a utility that leads to the utility's behavioral norms.
 - The utility's financial support of community cultural events.
144. What is workforce planning?
- Attending career fairs to recruit future employees.
 - Ensuring that your utility has the correct number of people with the necessary capabilities for the work needing to be done.
 - Forcing employees to perform undesirable tasks.
 - Helping employees to plan and prepare for examinations.
145. Why should you value the safety, health and welfare of your staff?
- To avoid visits from safety regulatory agencies.
 - To establish credibility and demonstrate sincerity in your personal interest towards staff.
 - To impress top administration with your managerial skills.
 - To indicate to insurance companies that low rates are appropriate.
146. If your Lift Station Wet Well is 72" in diameter and there are 35" between the pump 'On' level and the pump 'Off' level, how long will it take (in minutes) to pump one cycle if the pump output is 150 GPM? Assume no flow into the Wet Well.
- 8.91 Minutes
 - 4.11 Minutes
 - 0.68 Minutes
 - 7.39 Minutes
147. You have a submersible pump that delivers 12.5 HP (water horsepower), what is the efficiency of its motor if it delivers 14.0 HP at the shaft (Brake Horsepower)?
- 75%
 - 80%
 - 89%
 - 93%



148. Using the information below, determine the life cycle cost of a 35 HP pump that has been in service for 68 months:
- Purchase price: \$8,500.00 (installed)
 - Average monthly maintenance cost: \$79.17
 - Average Monthly Electricity cost: \$144.33
 - Total Repair costs: \$1,243.98
- a. \$12,425.98
b. \$19,967.48
c. \$24,941.98
d. \$7,898.78
149. Your lift station has a 4-inch force main pipe 500 feet in length. If the pressure on the check valve at your lift station is 95 psi, what is the static head the pump has to overcome?
- a. 41.14
b. 43.3
c. 231.0
d. 219.45

END OF PRACTICE TEST



Practice Test Answer Key

The following tables show the correct answers for the test questions included in this study guide. The tables below show what section the answers are for, the correct answer, and the subsection the question refers to. If you marked a wrong answer to any of the practice test questions, refer to the subsection listed and you will be able to find the correct reference material to study to help you correctly answer the question.

No.	Answer	KSAs	No.	Answer	KSAs
1	d	412	39	c	411
2	d	412	40	b	400
3	b	412	41	d	400
4	c	412	42	d	417
5	c	412	43	b	400
6	d	412	44	d	404
7	a	402	45	b	404
8	a	400	46	d	415
9	a	400	47	a	400
10	c	417	48	c	400
11	a	400	49	b	400
12	d	400	50	c	400
13	d	412	51	b	400
14	a	409	52	a	411
15	d	400	53	c	417
16	b	417	54	b	400
17	a	400	55	d	400
18	b	408	56	d	404
19	b	402	57	c	418
20	d (see solutions)	408	58	a	400
21	a (see solutions)	408	59	b	400
22	d (see solutions)	405	60	d	400
23	a (see solutions)	405	61	d	411
24	d (see solutions)	414	62	a	415
25	c	419	63	c	415
26	b	402	64	a	400,406
27	a	409	65	c	400
28	b (see solutions)	414	66	a	400,406
29	c	408	67	c	400
30	d (see solutions)	400	68	d	400
31	a	400	69	b	418
32	b	402	70	c	400
33	c	400	71	b	400
34	b	400	72	a	400,406
35	c	400	73	b	400
36	d	400	74	b	413
37	b (see solutions)	403	75	d	414
38	c	400	76	a	407



No.	Answer	KSAs	No.	Answer	KSAs
77	c	416	114	d	401,406
78	a	407	115	b	404
79	a	418	116	a	401,410
80	b	410,416	117	b	407
81	c	408,413	118	d	407
82	c	401,404,405,406,410	119	a	413
83	b	419	120	d	407
84	d	405,406,414	121	d	407,410
85	d	407	122	c	405
86	c	411	123	c	406,407
87	a	407	124	d	413
88	d	407	125	d	407,412,415,418
89	a	419	126	b	403,406
90	c	414	127	c	404,417
91	d	409,414	128	c	416
92	c	401,405,406	129	a	409
93	b	406,410	130	c	408,409
94	c	406,410	131	c	407
95	d	406,410	132	c	403
96	a	419	133	c	401,406
97	d	403	134	a	408,414
98	b	403,407	135	a	405,414
99	b	418	136	b	414
100	c	408,415	137	b	419
101	c	401	138	a	401,405,406
102	a	413	139	d	406
103	b	416	140	a	406
104	b	407	141	d	404
105	c	414	142	c (see solutions)	402
106	a	401,405,406,404,410	143	c	404
107	c	419	144	b	407
108	d	407	145	b	412
109	d	401,410	146	b (see solutions)	400
110	d	403,407	147	c (see solutions)	405
111	a	416	148	c (see solutions)	408
112	c	407	149	d (see solutions)	400
113	b	407			



Solutions for Selected Questions

20. If a 35-hp pump is running at 85%, what is the brake horsepower required?

Solution.

$$\text{Brake Horsepower} = \frac{\text{Water Horsepower}}{\text{Efficiency}}$$

$$\text{bhp} = \frac{\text{whp}}{E_f} = \frac{35 \text{ hp}}{0.85} = 41.2 \text{ bhp}$$

21. What is the power cost of a 75-hp pump if the pump runs 144 hours with a power cost of \$0.06125/kWh for one week?

Solution.

First calculate kilowatts required:

$$75 \text{ hp} \times \frac{746 \text{ watts}}{\text{hp}} = 55,950 \text{ watts}$$

Then convert watts to kilowatts

$$55,950 \text{ watts} \times \frac{\text{kw}}{1000 \text{ watts}} = 55.95 \text{ kw}$$

The power consumption for the week is

$$55.95 \text{ kw} \times 144 \text{ hours} = 8,049.6 \text{ kWh}$$

Power cost is:

$$8049.6 \text{ kWh} \times \frac{\$0.06125}{\text{kWh}} = \$493.04$$

22. For one week the following flows were recorded daily: 4.6 MGD, 5.2 MGD, 5.3 MGD, 4.9 MGD, 5.4 MGD, 5.1 MGD, 4.8 MGD. What was the average daily flow for the week?

Solution.

The average is the sum of the values divided by the number of valves.

$$\frac{4.6 + 5.2 + 5.3 + 4.9 + 5.4 + 5.1 + 4.8}{7 \text{ Day}} = \frac{35.3}{7} = 5 \text{ MGD}$$



23. The following flows were recorded for the months of June, July, and August: June 125.6 MG; July 142.4 MG; August 160.2 MG. What was the average daily flow for this three-month period?

Solution.

In this case, the average daily flow is calculated by the sum of the monthly flows (total flow) divided by the number of days in the three months.

$$\frac{125.6 + 142.4 + 160.2}{(30 + 31 + 31)} = \frac{(428.2 \text{ MG})}{92 \text{ days}} = 4.65 \text{ MGD}$$

24. If the sewer rate is \$5.50 for the first 500 cubic feet and all consumption over the minimum is billed at the rate of 25 cents per 100 cubic feet, how much would a customer using 1,200 cubic feet be billed?

Solution.

Cost = Base + Excess Use x Rate

$$\begin{aligned} &= \$5.50 + \left(\frac{1,200 - 500}{100} \right) \text{ft}^3 \times \$0.25/100 \text{ft}^3 \\ &= \$7.25 \end{aligned}$$

28. Your system's billing is based on the water usage rate. If your system bills quarterly at a rate of 50 cents/1,000 gallons for the first 10,000 gallons, \$0.41/1,000 for the next 15,000 gallons and \$0.25/1,000 for all over 25,000 gallons. If a customer uses 35,000 gallons per quarter, what is the bill?

Solution.

$$10,000 \text{ gal} \times \frac{\$0.50}{1,000 \text{ gal}} = \$5.00$$

$$15,000 \text{ gal} \times \frac{\$0.41}{1,000 \text{ gal}} = \$6.15$$

$$10,000 \text{ gal} \times \frac{\$0.25}{1,000 \text{ gal}} = \$2.50$$

$$\$5.00 + \$6.15 + \$2.50 = \$13.65$$

30. If a flow of 750 gpm is entering a wet well that is 50 feet long by 20 feet wide by 12 feet deep, what is the average detention time?

Solution.

$$t \text{ min} = \frac{V \text{ gal}}{Q \text{ gpm}}$$



$$V \text{ gal} = (l \times w \times h) \text{ ft}^3 \times \frac{7.48 \text{ gal}}{\text{ft}^3}$$

$$t \text{ min} = \frac{50 \text{ ft} \times 20 \text{ ft} \times 12 \text{ ft}}{750 \text{ gpm}} \times \frac{7.48 \text{ gal}}{\text{ft}^3} = 119.68 \text{ min}$$

$$= 120 \text{ min}$$

37. The current (2) pumps in your Duplex Lift Station have 40 HP motors and are 75% efficient. You intend to replace them with new pumps that are the same horsepower, but are 90% efficient. How much can you expect to save in electrical costs per month with the new pumps?

Assume:

- One month = 30 Days
- Each pump runs 12 hours per day average
- Electricity costs 3.7 cents per kw hour
- Round answer to nearest dollar

- a. \$88.00
- b. \$177.00
- c. \$129.00
- d. \$99.00

Solution.

$\frac{(\text{Water HP})}{\text{Efficiency\%}} \times 12 \text{ hr/day} \times 30 \text{ day/mo.} \times 0.746 \times \$0.037/\text{Kw. Hr}$

Step 1 - Figure electrical cost of old pumps.

$$\frac{40 \text{ HP}}{0.75} \times 12 \text{ hrs/day} \times 30 \text{ days/mo} \times 0.746 \times \$0.037$$

53.3 HP x 360 hrs/mo x 0.746 x \$0.037 = \$529.63 for one pump. \$1059.25 for both pumps.

Step 2 – Figure costs of new pumps.

$$\frac{40 \text{ HP}}{0.90} \times 12 \text{ hrs/day} \times 30 \text{ days/mo.} \times 0.746 \times \$0.037$$

44.4 HP x 360 hrs/mo x 0.746 x \$0.037 = \$441.19 for one pump. \$882.38 for both pumps.

Step 3 – Determine the cost difference of the old and new pumps

Old Pump cost of \$1059.29/mo – New Pump Cost of \$882.38/mo. = **\$176.87**



55. How many feet will a six-inch sewer drop in 315 feet with a slope of 0.7%?

Solution.

$$\begin{aligned} \text{Elevation ft} &= (\text{grade, \%}) \times (\text{Run, ft}) \\ &= 0.7\% \times \frac{1}{100\%} \times 315 \text{ ft} \\ &= .007 \times 315 \text{ ft} \\ &= 2.20 \text{ ft} \end{aligned}$$

142. A bypass operation is required to complete a repair on an 18-inch pipe, flowing full, that has a velocity of 2.5 fps. To maintain flows, your pump must have a minimum output (in GPM) of:

- a. 2,080 GPM
- b. 1,440 GPM
- c. 1,981 GPM
- d. 3,066 GPM

Solution.

Step 1- figure the area of the 18-inch pipe

Formula $D^2 \times 0.785$

Convert 18 inches to feet ($18" / 12" = 1.5'$)

$$\begin{aligned} 1.5 \times 1.5 \times 0.785 &= 1.766 \\ \text{Area} &= 1.766 \text{ Sq. ft} \end{aligned}$$

Step 2 – Figure the Flow Rate

Formula: $Q = A \times V$

$$Q = 1.766 \text{ cu. ft} \times 2.5 \text{ fps}$$

$$Q = 4.415 \text{ cfs}$$

Step 3 – Convert CFS to GPM

$$4.415 \text{ cfs} \times 448.8 = \mathbf{1,981.45 \text{ GPM}}$$

Your pump would have to be able to pump at a rate of 1,981 GPM



146. If your Lift Station Wet Well is 72" in diameter and there are 35" between the pump 'On' level and the pump 'Off' level, how long will it take (in minutes) to pump one cycle if the pump output is 150 GPM? Assume no flow into the Wet Well.
- 8.91 Minutes
 - 4.11 Minutes
 - 0.68 Minutes
 - 7.39 Minutes

Solution.

Formula: $D^2 \times 0.785 \times d$

Convert inch to feet:

$$72" / 12 = 6'$$

$$35" / 12 = 2.92'$$

$$6^2 \times 0.785 \times 2.92$$

$$36 \times 0.785 \times 2.92 = \underline{82.52} \text{ Cubic Feet}$$

$$82.52 \text{ Cu/Ft} \times 7.48 \text{ gallons} = \underline{617.25} \text{ Gallons}$$

$$617.25 \text{ gallons} / 150 \text{ GPM output from pump} = \underline{\mathbf{4.11 \text{ Minutes}}}$$

147. You have a submersible pump that delivers 12.5 HP (water horsepower), what is the efficiency of its motor if it delivers 14.0 HP at the shaft (Brake Horsepower)?
- 75%
 - 80%
 - 89%
 - 93%

Solution.

Formula: Water Horsepower / Brake Horsepower = Efficiency

$$12.5 \text{ HP} / 14.0 \text{ HP} = 0.89$$

Answer: 89%



148. Using the information below, determine the life cycle cost of a 35 HP pump that has been in service for 68 months:

- Purchase price: \$8,500.00 (installed)
- Average monthly maintenance cost: \$79.17
- Average Monthly Electricity cost: \$144.33
- Total Repair costs: \$1,243.98

- a. \$12,425.98
- b. \$19,967.48
- c. \$24,941.98
- d. \$7,898.78

Solution.

Purchase Price:	\$8,500
Monthly Maintenance: \$79.17 x 68 months =	\$5,383.56
Monthly Electric costs: \$144.33 x 68 months =	\$9,814.44
<u>Total Repair costs:</u>	<u>\$1,243.98</u>
	\$24,941.98

149. Your lift station has a 4-inch force main pipe 500 feet in length. If the pressure on the check valve at your lift station is 95 psi, what is the static head the pump has to overcome?

- a. 41.14
- b. 43.3
- c. 231.0
- d. 219.45

Solution.

Formula: pressure (PSI) x 2.31

95 psi x 2.31 = 219.45 head feet



Study Materials

The following section includes the titles and information of primary and secondary references for the Technologist. Because these references contain the majority of the information needed for the CWEA certification test, it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

The Internet is also a valuable resource. However, when searching for material the source should be considered and your search information should be as targeted as possible to obtain the resource requested. If possible, you should target colleges, government agencies, public works agencies and similar trustworthy sources for your requests.

Study Materials Referenced in Section 3

- *Operations and Maintenance of Wastewater Collection Systems, Volume I 6th Edition*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916-278-6142 www.owp.csus.edu.
- *Operations and Maintenance of Wastewater Collection Systems, Volume II 7th Edition*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916-278-6142 www.owp.csus.edu.
- *Manage For Success: Effective Utility Leadership Practices*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916-278-6142, www.owp.csus.edu
- *Confined Space Entry, WEF, Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994, 800/666-0206, www.wef.org*
- *Utility Management*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916/ 278-6142 www.owp.csus.edu.
- *Wastewater Collection System Maintenance*
Michael J. Parcher, CRC Press.
800/272-7737 Fax: 800/374-3401, www.crcpress.com.
- *Mathematics for Collection System Operators, a Workshop Manual*
OCT, Inc.
P.O. Box 332, Gladstone, OR 97027, www.octinc.com



- *Confined Space Entry*
Water Environment Federation
601 Wythe Street, Alexandria, VA. 22314-1994, Phone: 1-800-666-0206, www.wef.org.
- *Safety and Health in Wastewater Systems, WEF Manual of Practice SM-1*
Water Environment Federation
601 Wythe Street, Alexandria, VA 22314-1994, 800-666-0206, www.wef.org
- *Wastewater Collection Systems Management WEF Manual of Practice No. 7*
Water Environment Federation
601 Wythe Street, Alexandria, VA 22314-1994, 800-666-0206, www.wef.org
- *Supervision Concepts and Practices of Management*
Raymond L. Hilgert and Edwin C. Leonard, Thomson Learning
www.thomsonedu.com
- *What Every Supervisor Should Know*
Lester R. Bittel and John W. Newstrom, McGraw-Hill, Inc.
800-262-4729, www.mcgraw-hill.com
- *Effective Supervisory Practices: Better Results Through Teamwork*
ICM International, City/Council Management Association
1-800-745-8780, www.icma.org

Additional Study Materials

- *The Math Text for Water and Wastewater Technology, Second Edition*
Wrights Training
P.O. Box 515, Elmira, CA. 95625-0515, 707-448-3659, www.wrights-trainingsite.com
- *Applied Math for Wastewater Operators*
Joan Kirkpatrick Price, CRC Press
1-800-374-3401, www.crcpress.com
- *Traffic Manual Chapter 5 Traffic Controls for Construction and Maintenance Work Zones*
State of California, Department of Transportation
1900 Royal Oaks Drive, Sacramento, CA 95815, <http://www.dot.ca.gov/hq/traffops/signtech/signdel/trafficmanual.htm>
- *California Manual on Uniform Traffic Control Devices for Streets & Highways*
State Of California Business, Transportation And Housing Agency Department Of Transportation
www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd/CAMUTCD-Part9.pdf
- *Statewide General Waste Discharge Requirements for Sanitary Sewer Systems Order No. 2006-0003-DWQ.*
http://www.swrcb.ca.gov/rwqcb9/water_issues/programs/sso/docs/2006_0003.pdf



You and Wastewater Math

By Cheryl Ooten, Santa Ana College email: ooten-cheryl@rsccd.org

Example math problems found in Appendix A are representative of general wastewater math and are designed to illustrate a math problem solving strategy, not specific math skills. Examples given in this appendix may not be like the problems given on the test for your discipline. However, the problems are typical of types of problems you may encounter, including, but not limited to, basic algebra (solving one equation for one unknown), story problems, and geometry, (area and volume problems). For specific kinds of math skills and problems you may encounter on the Collection System Maintenance certification test, please review Sections 3, 4, and 5 of this study guide.

Section 1: Introduction

Now is the time for you to begin preparation for the math portion of your technical certification exam. This Appendix provides suggestions to take charge of:

- Your math skills
- Your attitudes toward math
- Your test-taking skills

By doing this, you can improve your performance in successfully completing the math questions on the certification exam.

Two Facts to Consider

First, since early childhood, you have used math mostly without giving it a second thought. Knowing your age, counting, comparing sizes and shapes, adding your money, and subtracting to get change are math skills.

You drive the streets judging distances, speeds, and times. You estimate if you can afford a vacation or a car and when you can retire. You compare volumes and areas as you build and do jobs around the work site. You even measure volume in putting toothpaste on your toothbrush. You use statistics as you watch sports and consider things like RBIs in baseball or field goal percentages in basketball. All of these are mathematical skills many people take for granted.

Second, if you think math is hard, please know that math becomes hard for *everyone* at some point. You are not alone. There are math problems that have been unsolved for hundreds of years even though they have been attempted by competent, well-informed mathematicians who may work at them for decades. Those are not the problems you need to work unless you are curious. When you work at your appropriate level, you find a combination of easy ideas and hard ideas.

You may get discouraged comparing your speed and understanding in math with others. Those people who appear to do math easily have, most likely, done those specific problems, or ones like them, many, many times.



You will want to study and progress at your “growing edge”—the skill level where you have a bit of discomfort with new material, but where you are not totally overwhelmed. You can expect challenges that trouble you, but that can be overcome. Instead of saying “I cannot do math,” decide now to begin learning enough math to make work and test-taking easier.

Move Beyond the Math You Know

To move beyond your routine skill level in math, consider the following points:

You Have Skills. You already have many math skills and can build on that base. It is best and easiest to build on what you already know.

Basics are Important. Going back over the basics of what you know will build confidence and help you progress and add new math skills to your ability to solve math problems.

Math Progresses Logically. There are many different areas of math and each builds on itself as well as on the others. If you cannot do a particular problem, it may be because you have missed something basic to that one area along the way. Working your way up slowly and cumulatively in math is the fastest way to gain skills.

Words Count. Each and every word and symbol in math means something. You need to find out those meanings and then practice them. If you do not know what “mgd” or “psi” means, or which units measure “flow”, it is harder to do problems involving them. It can seem like a foreign language.

Brains are Unique. Each individual brain is wired differently, causing each person to think and learn differently. The more you know about the way you as a specific individual learn, the more you will permit yourself to do what it takes to learn math. Some people need to do many written repetitions. Some need to walk or move around as they do math. Some need to talk out loud. Others need to draw pictures. Some need to work problems with other people. Some need to use words and some need to use symbols. In order to focus on how to move forward, think about what works for you or where learning has been difficult for you.

If you are an independent learner, you might find a basic math book at your library to work through on your own. You may be able to study with your own children to learn some math together or with your friends and colleagues. You may have an old math book you used a long time ago that could be helpful, and you may come to remember what you learned from it.

Assessment Helps. Assess your skill level honestly. Math placement tests are available at your local college and through private educational agencies to help you determine where your skills are and where you can best get help to make comfortable progress.

You are Not Alone. No one promises that math will always be easy or interesting for you. For most people, working on math is a challenge. Persevering and pushing personal limits allows you to experience the satisfaction of success.

Get help when you get discouraged or experience confusion. Remember this is just a momentary problem in a sequence of ideas that you are confronting. Do not buy into the myth that you have to do math alone. Do not believe it is demeaning for you to admit you do not understand. You can have fun if you lighten up as you progress. Working with others is an outstanding way to improve math skills.



Questions are Essential. Make a list of people with whom you feel comfortable discussing your math questions. They may be your colleagues, teachers, fellow students, friends, or family members—even your children. Do not ask just anybody; pick people who are helpful and positive or non-judgmental about your questions.

Mistakes Happen. Expect mistakes up front. As you learn anything new, you will make errors. Do not blame your mistakes on math itself! In any new endeavor you need to allow yourself to crawl before you can walk. Successful people in all fields know this. Trial and error is the basis of all learning.

You can learn more from your mistakes than from repeated successes. Making errors gives you feedback by showing you what you do not understand. Learn to value and accept those errors and use them to find out what areas of your learning need more work. Correct them and then move on with new knowledge.

Learning Math is Not a Competitive Game. Physicist Albert Einstein, politician Winston Churchill, and inventor Thomas Edison were all considered slow in school. Musical composer Ludwig Van Beethoven and scientist Louis Pasteur probably had learning disabilities. What all five certainly had was determination and patience to persevere. Only compete with yourself, pushing yourself forward, in learning math.

There is Hope for Those with Learning Disabilities. If you really have a hard time learning, you might ask your local college or a private learning specialist to assess you for a learning disability. Many colleges and universities do free testing and training for their students. You can also purchase this kind of assistance from private consultants. Much is now known about learning disabilities and how to help people who have them. Learning disabilities often become just learning differences as students learn to honor and use their own thinking and learning styles.

Math Success and Test-Taking Success are Not the Same. Many math students understand and can work math problems, but have difficulty in test-taking situations. It is possible to know math and still fail exams. These people may find Section 4 “Test-Taking Strategies” very helpful. Conscious practice of both math skills and test-taking skills can make a big difference in your score.

Resources are Available. Resources exist for all types of math. You will need to decide whether you will work on your math skills independently or with the help of some structure such as a math course or a tutor. Different strategies may work better at different stages in your progress.

Your local community college has inexpensive math courses. Some colleges even have math courses specifically for water and wastewater professionals. Professional organizations sponsor training conferences and seminars which include math courses specific to the field. Many agencies can provide in-house training and many agencies will provide individual help with all aspects of test taking.

Community Colleges. Community colleges offer several types of services including:

- Math Placement Testing
- Math Courses
- Water Utility Science Courses
- Math Anxiety Reduction Courses
- Testing and Training for those with



Learning Disabilities

Professional Organizations. Organizations such as the California Water Environment Association (CWEA), American Water Works Association, and American Public Works Association also provide opportunities to practice your math skills and network with others:

- CWEA local section study sessions
- Technical Certification Training Classes and Annual Conferences
- CWEA Northern Regional Training Conferences
- CWEA Study Manuals

At Work. Ask for help and suggestions from others who have taken math courses or are skilled in the work area similar to the one you are trying to prepare or improve. Ask your supervisor for advice on how to prepare and how much time on the job you can have to prepare. Ask your supervisor to provide training classes for the areas that you are wanting to improve. Ask those managing other departments, agencies, or local professional organizations for help in the training you need.

Materials. Any basic math book or instructional manual that you can beg, borrow, or buy, including:

- Courses from Ken Kerri, Office of Waste Programs, California State University, Sacramento, 6000 J Street, Sacramento, CA 95819.
- Price, Joanne Kirkpatrick. *Basic Math Concepts for Water and Wastewater Plant Operators*. Lancaster, Pennsylvania: Technomic, 1991.
- Smith, Richard Manning. *Mastering Mathematics: How to Be a Great Math Student*, 3rd Ed. Pacific Grove, CA: Brooks/Cole, 1998.
- Zaslavsky, Claudia. *Fear of Math*. New Brunswick, NJ: Rutgers University Press, 1994.

Section 2: Practice Problem Solving Strategies

Wastewater math deals with only a handful of basic types of problems that involve moving liquids and semi-solids from place to place, and manipulating, storing, and treating these substances along the way.

So basically, understanding area, volume, slope, rates, concentrations, costs, and time elements that occur in wastewater treatment 24 hours per day, 365 days per year, pretty much covers what you need to know.

Units and Arithmetic

All wastewater math problems can be solved by simple arithmetic—adding, subtracting, multiplying, and dividing. You can become proficient with wastewater math by paying careful attention to the units in the problems as you write down your strategies, and then using a calculator to do the needed arithmetic. Make sure you use only a calculator that you can take into the test site (see www.cwea.org/cbt for a list of approved calculators).

Units. Units such as cubic feet, gallons, gpm, and mgd are important in wastewater math problems. Paying attention to the units will tell you whether to multiply or divide. Also, the units will often help you know what numbers to multiply or divide.



Notice in each example that doing math operations on the units produces the correct units in the answer. Many people do the math on the units first to figure out the correct procedure before they ever do the math on the numbers.

Multiplying. Multiplying is important. There are several symbols for multiplication. They are •, x, and ().

For example,

$$2 \cdot 3 = 2 \times 3 = (2)(3) = 6$$

Dividing. Dividing is important to wastewater math because units often used such as mgd, cfs, ppm, gpm, psi, mg/L, gpd/sq.ft., and % are really division problems.

“Per” stands for “divided by”.

$$\text{mgd} = \frac{\text{million gallons}}{\text{day}}$$

$$\text{cfs} = \frac{\text{cubic feet}}{\text{second}}$$

$$\text{ppm} = \frac{\text{parts}}{\text{million}}$$

$$\text{gpm} = \frac{\text{gallons}}{\text{minute}}$$

$$\text{psi} = \frac{\text{pounds}}{\text{square inch}}$$

$$\text{mg/L} = \frac{\text{milligrams}}{\text{Liter}}$$

$$\text{gpd/square foot} = \frac{\text{gallons/day}}{\text{square foot}}$$

$$10\% = \text{ten percent} = \frac{10}{100}$$

Example Problems

Example 1. Plant No. 1 measured a flow of 3.5 million gallons in half a day. If the peak flow (hydraulic) capacity of the plant is 8 mgd, is there need for concern?

Using the conversion factor:



$$\text{mgd} = \frac{\text{million gallons}}{\text{day}}$$

divide 3.5 million gallons by half a day.

$$\text{mgd} = \frac{3.5 \text{ million gallons}}{0.5 \text{ day}} = 7 \text{ mgd}$$

7 mgd is less than the peak flow capacity, 8 mgd. There is no need for concern yet.

Example 2.

a. Find the number of gallons in 10 cubic feet.

Since we can pour 7.48 gallons into a 1 cubic foot container, that means that 7.48 gallons = 1 cubic foot. We can use either factor:

$$\frac{7.48 \text{ gal}}{1 \text{ cu ft}} \text{ or } \frac{1 \text{ cu ft}}{7.48 \text{ gal}}$$

to convert cubic feet units into gallons or vice versa

$$\frac{10 \text{ cu ft}}{1} \cdot \frac{7.48 \text{ gal}}{1 \text{ cu ft}} = \frac{(10 \text{ cu ft})(7.48 \text{ gal})}{1 \text{ cu ft}}$$

$$= 74.8$$

Notice that using the first factor allows the unit "cu ft" to cancel out leaving the answer in gallons.

b. Find the number of cubic feet in 10 gallons. Notice that using the second factor allows the unit "gal" to cancel out leaving the answer in cubic feet.

$$\frac{10 \text{ gal}}{1} \cdot \frac{1 \text{ cu ft}}{7.48 \text{ gal}} = \frac{(10 \text{ gal})(1 \text{ cu ft})}{7.48 \text{ gal}}$$

$$= 1.34 \text{ cu ft}$$

You will notice how important it was in these examples to consider the units in deciding whether to multiply or divide by 7.48.

Example 3.

a. Find the detention time for a basin with 675,460 gal if the flow is 1,000,000 gal/day.

Flow is always a rate which is division. Units like gpd or cfs are both division.



The formula for the basin detention time is

$$D_t = \frac{\text{volume}}{\text{flow}}$$

$$\begin{aligned} D_t &= \frac{675,460 \text{ gal}}{1,000,000 \text{ gal/day}} \\ &= \frac{675,460 \text{ gal}}{1} \cdot \frac{\text{day}}{1,000,000 \text{ gal}} = 0.675 \text{ days} \end{aligned}$$

- b. Find the detention time for a 426 cubic foot basin if the flow is 1,000 cfs.

$$\begin{aligned} D_t &= \frac{426 \text{ ft}^3}{1,000 \text{ cfs}} = \frac{426 \text{ ft}^3}{1,000 \frac{\text{ft}^3}{\text{sec}}} = \frac{426 \text{ ft}^3}{1} \cdot \frac{\text{sec}}{1,000 \text{ ft}^3} \\ &= 0.426 \text{ sec} \end{aligned}$$

Example 4.

Find the number of gallons of an 11% polymer needed to produce 100 gal of a 0.75% solution. Use the formula $C_1V_1 = C_2V_2$ where C = concentration or % and V = volume.

You can let the volume you are looking for (i.e. the number of gal of 11% polymer) be represented by V_1 . Then $C_1 = 11\%$ or 0.11, $C_2 = 0.75\%$ or 0.0075, and $V_2 = 100$ gal.

Using the formula $C_1V_1 = C_2V_2$, you have $(0.11)(V_1) = (0.0075)(100)$

Notice to find V_1 , you do the opposite of multiplying (i.e. dividing) by 0.11 on both sides. You then have

$$\frac{(0.11)(V_1)}{0.11} = \frac{(0.0075)(100)}{0.11}$$

and using a calculator, $V_1 = 6.82$. So, the amount needed is 6.82 gal.

Example 5.

How many hours will it take to empty a 43,000 cubic foot tank if it empties at a rate of 2.7 cubic feet per second?

Notice that dividing 43,000 cubic feet by 2.7 cubic feet per second would make the cubic feet unit cancel out. This would give us the time in seconds. To convert seconds into hours, use the factors



$$\frac{1 \text{ min}}{60 \text{ sec}} \text{ and } \frac{1 \text{ hr}}{60 \text{ min}}$$

The work is given below.

Notice how the units cancel out leaving the answer in hours.

$$\text{Time} = \frac{43,000 \text{ ft}^3}{2.7 \frac{\text{ft}^3}{\text{sec}}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} = 4.42 \text{ hr}$$

Example 6.

Find the number of gallons of water in a rectangular basin 200 ft long, 50 ft wide, and 12 ft deep.

First, find the volume of the rectangular basin by multiplying length by width by height. Volume = (200 ft)(50 ft)(12 ft) = 120,000 cubic feet or cu ft or ft³.

You now have a problem similar to Example 2. How many gallons are there in 120,000 cubic feet?

Use the factor $\frac{7.48 \text{ gal}}{1 \text{ cu ft}}$ to convert cubic feet into gallons.

$$\text{volume} = \frac{120,000 \text{ cu ft}}{1} \cdot \frac{7.48 \text{ gal}}{1 \text{ cu ft}} = 897,600 \text{ gal}$$

Example 7.

A cylindrical tank is full to 3 feet below the top at 10 a.m. and empty at 4 p.m. If the tank is 50 ft tall with a diameter of 70 ft, find the volume (in gal) of the liquid at 10 a.m. and the rate of flow from the tank in gal per minute.

For a math problem with many words, I recommend always first writing down what you are trying to find:

- First, find the number of gal of water in the tank at 10 a.m.
- Second, find the rate of flow in gal/min.

Drawing a sketch helps some people understand the problem and helps to keep track of the data.

I also like to write down and interpret the details that are given to me like:

Full to 3 ft below the top at 10 a.m.
 Empty at 4 p.m.
 Takes 6 hours to empty

The solution is presented in two parts.

- First, to find the volume in gal at 10 a.m., use the formula for volume of a cylindrical



tank which is $V=(\text{area of the base}) \times (\text{height})$.

To find the area of the base of the tank which is a circle, multiply 0.785 times the diameter squared.

So, the area of the base = $0.785(70^2) = 3,846.5 \text{ sq ft}$.

The height at 10 a.m. is 47 ft because the tank is filled to 3 ft below the top.

Volume = $(\text{area of the base})(\text{height}) = (3846.5 \text{ ft}^2)(47 \text{ ft}) = 180,785.5 \text{ ft}^3$

However, you want the volume in gal so use the factor $\frac{7.48 \text{ gal}}{1 \text{ cu ft}}$ to convert.

Volume in gallons =

$$(180,785.5 \text{ ft}^3) \left(\frac{7.48 \text{ gal}}{1 \text{ ft}^3} \right) = 1,352,275.54 \text{ gal}$$

b. Second, to determine the rate of flow in gallons per minute, divide the number of gallons by the number of minutes it took the tank to empty. It took 6 hours to empty. To convert 6 hours to minutes, use $60 \text{ min} = 1 \text{ hour}$ or factors $\frac{60 \text{ min}}{1 \text{ hour}}$ or $\frac{1 \text{ hour}}{60 \text{ min}}$ to convert. You want the hour unit to cancel out, so you will use the first factor. The time becomes:

$$\left(\frac{6 \text{ hrs}}{1} \right) \left(\frac{60 \text{ min}}{1 \text{ hr}} \right) = 360 \text{ min}$$

Rate of flow in gal per minute =

Rate of flow in gallons per minute =

$$\frac{1,352,275.54}{360 \text{ min}} = 3,756.32 \text{ gal per min}$$

Section 3: Take Charge of Your Success

The key to progress with math is to consciously take charge of your thoughts and actions. Then, instead of letting math control you, you control math and you take charge of your success.

Recommendations

Ask Questions. Be active and assertive. Learning is not a spectator sport. You cannot learn well from the sidelines. Get involved. Work problems and keep asking questions until they become clear. In classes and seminars, ask questions on confusing procedures.

Take It Easy. When you get stuck working problems, hang in for a while and then take a break. Go back later, begin at the beginning with a clean sheet of paper and a different point of view. Just because you do not understand at first does not mean understanding will not come. Math learning requires time to settle into your brain. Being able to live with uncertainty for a while is a good math skill to have.



Keep a List. Write down your resources (books, tutors, people to answer questions, people who understand) so that you can consult them when you get discouraged. You are not alone. Find helpful people with whom you are comfortable. Form a network with others working toward the same goals as you.

Find Yourself. Discover your own unique ways of learning. Experiment with new ones. If a method does not work, find others. Ask different people how they learn math or do a problem. They will often feel honored and pleased that you asked them and you might get a breakthrough idea.

Be Positive. Listen to what you say to yourself inside your head. It is difficult to work well if you are saying, “I will never get this” or “I cannot do math.” Change those negative messages to neutral ones like “I have not learned this yet” or “I cannot do this particular problem yet.”

Reward Yourself. Acknowledge your progress—every little bit! Pat yourself on the back for each and every problem you work. Notice what you know now that is new that you did not know two weeks ago. Maybe even write it down to document your growth.

Learn From Mistakes. Remember that errors are part of the learning process. Pay attention to them and figure out where they happened and how to fix them.

Keep It Real. Be realistic with your expectations of yourself—your math level, your life commitments, and your time constraints. Do not beat yourself up for being a human being.

Use Technology. Learn to use a calculator and use it appropriately for calculations with large numbers and decimals. Be sure to use only an approved calculator for the test site (a list is available at www.cwea.org/cbt). Each brand of calculator is different so keep your manual for reference. Take spare batteries to exams.

Start Easy. Practice the easier math problems to warm up each time you begin your math study. This builds confidence and strengthens those math pathways in your brain.

Write Out Problems. You will be given a dry erase sheet to use at the test site. Practice math problems using scratch paper. Use this to think and do calculations.

Promote Emotional Well Being. Patience, self-care, and humor will make your math work so much easier. Your brain will work better too.

Be Healthy. You are making new connections in your brain as you practice math so sufficient sleep and healthy foods are important. Having fresh drinking water available and breathing fresh air also helps you think better.

Section 4: Test-Taking Strategies

There are many actions you can take before, during, and after exams that will improve your test-taking performance and outlook. Remember that math skills and test-taking skills are different from each other. This section will help you become conscious of your thoughts and actions regarding test preparation. Use these suggestions to take charge and approach your test confidently.



If you find yourself thinking negative thoughts about your coming exam, skip to the last section and read “Negative Thinking about Exams” first.

Before the Exam

Work Problems. Diligently prepare and practice. Repeat solving problems to gain speed and confidence. This takes work and time—sometimes many hours, even days. Going in to an exam with the knowledge that you have worked lots of problems boosts confidence. Prep time is invaluable.

Relax. Practice relaxation daily for about at least ten minutes using breathing. Sitting or lying comfortably, breathe slowly in through your nose counting to five and then out through your mouth counting to ten. If you feel dizzy, breathe normally for a while. Deep breathing activates chemicals in your body that help you relax and feel better. Any type of regular meditation, yoga, or slow stretching while breathing deeply can help facilitate your relaxation response. Practicing daily will help you control your adrenaline level during your exam. Using relaxation consciously during an exam frees up the thinking part of your brain. (Do not practice these deep breathing exercises while you are driving.)

Stay Active. Daily walks or biking or whatever aerobic exercise you use consistently prepares your body for your exam by relieving stress and keeping your state of mind positive. Your mind and your body are connected so tightly that they are nearly the same.

Rehearse. Do a dress rehearsal for your exam. Write or have someone assist you in writing a practice test with problems and questions that you think might be on the real exam. Take the practice test in this study guide in an environment as close to your testing situation and schedule as possible. Time it and then correct it to learn from your errors.

Plan Ahead. Plan ahead carefully so that you will get to the exam early—do not be in a rush. Know exactly how to get there and what you will wear so that you are comfortable. You might want to wear your “lucky” shirt or bring a photograph in your wallet of people who care about you and believe in you. WHATEVER you can do to increase your sense of comfort and security, do it. Ahead of time, pack a Testing-Taking Kit with sharp pencils, pens, a ruler, erasers, tissues or handkerchief, a bottle of water, extra calculator batteries, and anything else you think you might need that is allowed at the test.

Care For Your Body. Optimal food and rest are individual preferences. Plan these ahead of time. Some research has shown that a brisk walk before an exam has raised test results. Some research has shown that eating a few candies (not chocolate) right before an exam has raised test results. Protein appears to be essential for clear thinking. Be in charge of what happens to you before the exam. Do not let outside influences take charge of you for this little time before your test.

At the Exam

Do a Data Dump. Bring a short list of formulas or facts you find difficult to remember. Look at them before the test. Visualize them going into a holding tank in your brain. Practice making them subject to recall. You are not allowed to use notes on the exam, so be sure to put the list away so that your honesty is not questioned. When you start your test, quickly write these formulas or facts on your dry erase sheet. Now you do not have to expend any energy trying to recall them later when you need them.

Ignore Others. Ignore all of the other people at the test site—before, during, and maybe even after. Different people have different ways of dealing with their anxiety during tests (and remember, they are



likely to be taking a completely different test than you). Some people get a little hyper and try to rub off their anxiety on everyone else. Do not take on someone else's anxiety. Your test is not a competition so what other people do will not affect your score. Often the first person to leave an exam gets a very low score, while the last person to leave gets a very high score. Take your time. Pay no attention to other people's behavior.

Breathe. When you feel stuck or tense, take a deep breath. Let it all go as you expel the air. (The more you have practiced relaxation and deep breathing before the exam, the more you will relax during the test.)

Take Time Out. Take short breaks during the exam to close your eyes, breathe deeply, and stretch your neck and arms. Massaging your temples, scalp, and the back of your neck will increase blood flow with oxygen to your brain to help you think better. A few isometric exercises can release tension too.

Use Your Subconscious Mind. If a problem makes no sense, read it and go on. Ideas will come to you as the problem sinks into your subconscious mind while you continue with the test.

Trust. Let each question reach into your mind for the answer. Remind yourself that you know everything you need to know for now.

Strategize. Do the easy problems and questions first. Make pencil marks by the questions to which you want to return.

Use Time Wisely. Do not work on one problem for a long time. Often a question further into the exam will act as a "key" to unlock a previous problem. Tell yourself that you have all of the time you need. Let go of the rest of your life during the exam. You can deal with all that later.

After the Exam, Let the Results Go. You have used a lot of energy and may be low and off balance. You may wish to pass up discussing the exam with others so you can take care of yourself. Going to the bathroom, drinking some water, and eating something can help you feel normal again. You may have set much of your life aside to prepare for this exam. Refresh yourself and get your life back. You can deal with the test results later when your priorities are in order again.

Negative Thinking About Exams

Here are negative thoughts math students often think before test-taking. Put a check mark by the examples familiar to you. Recognizing the distorted thinking in each example can help you change negative thoughts to neutral or positive ones. If you need more assistance with overwhelming negative thoughts, I recommend the book *Feeling Good* by David Burns (WholeCare, 1999).

"I Will Fail." Unless you have a crystal ball and can see into the future OR unless you have made a definite plan NOT to prepare for the test OR unless you plan to "freeze up" during the exam, you have no way of knowing whether you will fail or not. Worrying about the future only takes energy from today.

"I Will Panic During the Test." It is not uncommon to be excited. An exam is a process during which you will experience many thoughts, feelings, and body sensations. Actors get nervous, yet they still perform. If you do panic, let panic leave you. It will. No one dies from panicking during an exam.

Preparation by practicing problems, asking questions, and reviewing gives you confidence and skills that you need. Taking a dress rehearsal test and trying to panic can help you practice dealing with out-of-control feelings. Learning some relaxation techniques to use before and during the exam



calms you and aids clear thinking. The more you prepare yourself ahead, the more you are in charge and feel relaxed.

“I Cannot Do Math.” Math is a very broad subject involving many different skills. If you can recognize shapes, tell time, and know where the front and back of a classroom are, you can already do math. There are many more math skills that you have and many that you do not have YET. There are also many that you will never choose to acquire. Instead of thinking so absolutely about math, find areas where you can grow and learn new skills instead of paralyzing yourself with this broad generalization.

“I Am Stupid.” Name calling is seldom productive. Occasionally you may feel stupid because you do not know something or you mess up. What really is happening is that you are being human and humans are not stupid. Educators recognize the need to change how everyone thinks about intelligence. They recognize that there are many different kinds of intelligence including:

- bodily/kinesthetic
- verbal/linguistic
- naturalist
- logical/mathematical
- visual/spatial
- interpersonal
- intrapersonal
- musical/rhythmic

This comes from the work of Howard Gardner [Gardner, Howard. *Multiple Intelligences: The Theory in Practice*. New York: Basic Books, 1993].

You are a wonderful combination of these talents—not just an IQ number. IQ Tests are limited because they only measure a few types of intelligence and ignore the rest. We are not all the same and cannot possibly know all there is to know in every situation. Between now and the exam, there are many questions you can get answered as well as many new skills you can practice and master if you use the skills and intelligence that you have.

“I Will Forget Everything.” Forgetting does not mean something is gone from your mind forever. The right cue will often help you remember what you need to know. Your exam will be filled with cues—words and symbols—that will trigger formulas and ideas you have practiced.

Expecting to forget “everything” is foretelling the future and making a broad generalization. Even most people with amnesia caused by illness or injury do not forget “everything.” If you are extremely worried about your memory, *The Great Memory Book* by Karen Markowitz and Eric Jensen (The Brain Store, 1999) can be of assistance to you.

“Math Tests Are Tricky.” Math students who rely on memorizing the material rather than understanding it are usually the ones who think tests are tricky. You will use your memory to add to your understanding of how to do the math. Your math problems will contain many units such as mgd or ft³ or psi. Learning how to skillfully convert back and forth between units of measure will take a lot of the trickiness away from your test problems. Practicing using your calculator will help too.

“There Is So Much I Do Not Know.” This will always be the case the rest of your life. It is the human condition. Taking a deep breath and finding the level where you can begin to learn will improve your feelings and your confidence.



Glossary

Technical Terms

Air gap: An open vertical drop, or vertical empty space, between drinking (potable) water supply and the non-potable point of use. This gap prevents back siphonage because there is no way wastewater can reach the drinking water. Air gap devices are used to provide adequate space above the top of a manhole and the end of the hose from the fire hydrant. This gap insures that no wastewater will flow out the top of a manhole, reach the end of the hose from a fire hydrant, and be sucked back up the hose to the water supply.

Asphyxiation: An extreme condition often resulting in death due to lack of oxygen and/or excess of carbon dioxide in the blood from any cause.

Atmospheric: Of or relating to the atmosphere.

Backfill: 1) Materials used to fill in a trench or excavation. 2) The act of filling a trench or excavation usually after a pipe or some type of structure has been placed in the trench or excavation.

Backflow Device: 1) A device that is placed in a sewer lateral to prevent accidental backflow or reverse flow of wastewater into a building. 2) A device used on potable water systems to prevent water from flowing back into a main from a private service line thereby eliminating any possible contamination.

Balling: A method of hydraulically cleaning a sewer or storm drain by using the pressure of a water head to create a high cleansing velocity of water around the ball. Special sewer cleaning balls have an outside tread causing them to spin or rotate resulting in a scrubbing action of the flowing water along the pipe wall.

Bedding: A prepared base or bottom of a trench or excavation on which a pipe or its structure is supported.

Biochemical Oxygen Demand (BOD): The rate at which microorganisms use the oxygen in water or wastewater while stabilizing decomposable organic matter under aerobic conditions.

Bucket machine: A powered winch machine designed for operation over a manhole. The machine controls the travel of buckets used to clean sewers, a mechanical type of cleaning.

Cardiopulmonary Resuscitation (CPR): Reviving the heart and lungs.

Centerline: Center of the width of a public or utility easement or roadway.

Channel: Provides a transition of wastewater from one or more inlet pipes to the outlet line. Located in a manhole.

Clean Water Act (CWA): The federal Clean Water Act sets the framework for the imposition of industrial



wastewater control programs on municipalities and the regulation of industrial users. Sections 307(b) and (c) of the Clean Water Act set forth the authority for U.S. EPA to establish pretreatment standards for existing and new sources discharging industrial wastewater to POTWs.

Coagulate: The use of chemicals that cause very fine particles to clump together in larger particles.

Combination Cleaner: Jet/vacuum trucks that can clean sewers and vacuum up debris simultaneously. A hydraulic type of cleaning.

Compaction: Tamping or rolling of a material to achieve a surface or density that is able to support predicted loads.

Cone: The part of a manhole that tapers up from the barrel to a manhole cover. Can be either of two types, concentric and eccentric.

Confined-Space: A space that is large enough and so configured that an operator can enter and perform assigned work and has limited or restricted means for entry or exit, potentially contains toxic gases, and is not designed for continuous occupancy.

Engulfment: The surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

Excavate: To dig a trench, cavity or hole for or with access to install pipe or other structures.

Hydrogen Sulfide Gas (H₂S): A gas with a rotten egg odor. This gas is produced under anaerobic conditions. H₂S is particularly dangerous because it dulls the sense of smell after prolonged exposure and because the odor is not noticeable in high concentrations. The gas is very poisonous to the respiratory system and is very explosive and flammable.

Infiltration: The water entering a sewer pipe including service connections from the ground. Defective pipes, pipe joints, connections or manhole walls are a few of the common location where infiltration can occur.

Invert: The lowest point of the channel inside a pipe or manhole.

Inflow: The water entering a sewer system through above-ground access points such as manhole covers and lift station hatches.

Jetter (High Velocity Cleaner): A machine designed to remove grease and debris from smaller diameter pipe with jets of high velocity water. Also called a “Jet Cleaner”, “Jet Rodder”, “Hydraulic Cleaner”, or “High

Line Cleaning: Collection system pipeline maintenance operations using hydraulic or mechanical cleaning methods.

Material Safety Data Sheets (MSDS): A document which provides pertinent information and a profile of a particular hazardous substance or mixture. The document is provided by the manufacturer of the substance or mixture.



Oxygen Deficiency: An atmosphere containing oxygen at a concentration of less than 19.5% by volume.

Parachute: A device used to catch wastewater flow to pull a float line between manholes.

Pathogen: A bacteria, virus, or cyst found in wastewater that can cause disease in a host.

Penetrator Nozzle: A type of high pressure water nozzle that is designed to penetrate blockages in sewer pipes, usually used with Jet Rodders or Combination Machines.

Porcupine: A type of mechanical tool used with a mechanical rodder. Its function is to scour lines of light build up in conjunction with water flushing of sewer lines.

Root Saw: A type of mechanical tool used with a mechanical rodder. Its function is to cut through, by sawing action, root masses in a pipe.

Sand Nozzle: A type of high pressure water nozzle that is designed to remove large amounts of sand or other light sediment in sewer pipes. Usually used with Jet Rodders or Combination Machines.

Sanitary Sewer Overflow (SSO): A discharge of wastewater from a location that is not authorized by a NPDES permit. A sanitary sewer overflow may be the result of a pipeline blockage, hydraulic overloading of pipelines or pump stations, equipment malfunctions, or damage to conveyance systems.

Shoring: Material such as boards, planks or plates, and hydraulic jacks used to hold back soil around trenches and to protect workers in a trench from cave-ins.

Square Bar Corkscrew: A type of mechanical tool used with a mechanical rodder. Its function is to remove roots and rigid obstructions in a pipe by cutting and tearing action.

Vitrified Clay Pipe (VCP): A type of pipe used in wastewater collection systems. Vitrified clay pipe is rigid and resistant to internal and external attack from acids, alkalies, gases, solvents and other materials found in wastewater.

Volatile Solvents: A solvent that is capable of being evaporated or changed to a vapor at relatively low temperatures.

Wet Well: A compartment or tank in which wastewater is collected. The suction pipe of a pump may be connected to the wet well or a submersible pump may be located in the wet well.

Worker Right-To-Know Law: Federal and State laws governing worker health and safety in the work place.



Management and Supervision Terms

Ability: The quality of being able to perform; a natural or acquired skill or talent.

Accident: Unplanned or uncontrolled event in which action or reaction of an object, material, or person results in personal injury.

Accountability: Non-assigned liability for the manner in which an organizational obligation held by a supervisor is discharged, either personally or by subordinates.

Active listening: Conscious process of securing information through full attention, intent listening, and alert observation.

Affirmative Action: In-company program designed to remedy current and future employment inequities.

Americans with Disabilities Act (ADA): Prohibits employment discrimination based on a person's mental or physical disability.

Appraisal interview: Meeting held between a supervisor and an employee to review performance rating and, using the evaluation as a basis, to discuss overall quality of work performed, and methods of improvement, if necessary.

Arbitration: Labor dispute or employee grievance settlement by an impartial umpire selected through mutual agreement by organization and worker's union.

Attrition – Gradual reduction in a work force due to natural events and causes, e.g. - retirement, death, resignation, as opposed to planned reductions, e.g.- discharges, layoffs, early retirement.

Authority: The power needed to do a specific job or to carry out one's responsibilities usually handed down from immediate bosses or superior.

Body language: Nonverbal body movements, facial expressions and/or gestures that project or reveal underlying attitudes and sentiments.

Budget: Plan, or forecast, especially of allowable expenses in operation of a department.

Budgetary control: Planning and reporting system incorporating standards for operating conditions and results as well as costs and expenses, within a single document.

Certification Exam: An examination administered by a state or professional association that candidates take to indicate a level of professional competence.

Chain-of-Command: Formal channels in an organization that distributes authority from top down.

Code of Federal Regulations (CFR): A publication of the United States Government that contains all of the proposed and finalized federal regulations, including environmental.



Collective bargaining: Process of give-and-take engaged in by management and collective employees representatives to reach formal, written agreement about wages, hours, and working conditions.

Communication process: Giving and receiving information and understanding such as between a supervisor and an employee, leading to a desired action or attitude.

Computerized Maintenance Management System (CMMS): A computerized system to assist with the effective and efficient management of maintenance activities through application of computerized elements including: work orders, routine standard jobs, bills of materials, application parts, and lists of all numerous other features.

Competition: Relatively healthy struggle among individuals or organizational groups to excel in striving to meet mutually beneficial goals.

Conflict: Disruptive clash of interests, objectives, or personalities between individuals or groups within an organization.

Control: To exercise authoritative influence over; the authority or ability to manage and/or direct.

Cost-benefit analysis: Technique for weighing pros and cons of alternative actions, in which both intangible benefits as well as costs are assigned dollar values.

Cost variance report: Listing of allowable expenses compared with actual expenses incurred.

Decision-making: Part of the problem-solving process that entails evaluation of alternative solutions and a choice of an effective action.

Delegation: The act in which power is given to another person in the organization to accomplish a specific job.

Differential treatment: Act of treating a minority or protected group member differently from other applicants or employees.

Discipline: Imposition of a penalty by management on an employee for infraction of a rule, regulation, or standard in such a manner as to encourage more constructive behavior.

Discrimination: Managerial action or decision based on favoring or disfavoring one person or group member over another on the basis of race, color, ethnic or national origin, sex, age, handicap, or Vietnam era war service, or union membership.

Division of work: Principle that performance is more efficient when a large job is broken down into smaller, specialized tasks.

Due process: Employee's legal entitlement to a fair hearing, usually before an impartial party and with appropriate representation, before discipline can be metered out.

Employee turnover: Measure of how many people come to work for an organization and do not remain employed by that organization, for whatever reason.

Ergonomics: Study of how workers react to their physical environment; used in design of more comfortable and productive workstations.



Equal Employment Opportunity (EEO): System of organizational justice, stipulated by law, that applies to all aspects of employment; intended to provide equal opportunity for all members of the labor force.

Feedback: Process of relaying measurement of actual performance back to an individual or unit so that action can be taken to correct, or narrow, the variance.

Geographical Information System (GIS): An integrated system of computer hardware, software, and trained personnel linking topographic, demographic, utility, facility, images, and other resource data that are geographically referenced.

Gantt chart: Chart that enables a planner to schedule tasks in the most productive sequence that also provides a visual means for observing and controlling progress.

Grievance: Job-related complaint stemming from an injury or injustice, real or imaginary, suffered by an employee for which relief or redress from management is sought.

Grievance procedure: Formalized, systematic channel for employees to follow in bringing complaints to the attention of management.

Hazard: Potentially dangerous object, material, condition, or practice present in the workplace, to which employees must be alert and from which they must be protected.

Hostile Work Environment: As applied to harassment, offensive speech or unwelcomed conduct that is severe or persuasive enough to create an abusive, antagonistic, or inhospitable work place.

Information Management System (IMS): System comprised of data processing devices, programs, and people, that collects, analyzes, exchanges, and delivers information to an organization in such a manner as to aid managers in making best possible decisions.

Information: Dates past or present facts, observation or conclusions collected in numbers and words that have been selected, arranged, and analyzed (processed) to make it useful for a specific human (managerial) activity.

Injury Illness Prevention Plan: Plan required by California Senate Bill (SB) 198 to establish, implement, and maintain an effective program helping assure employee safety while on the job. It includes eight elements: management assignments and responsibilities, safety communications system with the employees, system assuring employee compliance with safe working practices, scheduled inspections and compliance system, accident investigation, health and safety training and instruction, and record-keeping and documentation.

Job breakdown analysis: Segmentation of a job into key elements, or steps, of which an employee must perform, induce, or supervise an action that advances work toward completion.

Job evaluation: Systematic technique for determining job worth, compared with other jobs in an organization.

Just cause: Reason for a disciplinary action that is accurate, appropriate, well founded, deserved and meets the test of prior notification of unacceptable behavior and its penalty.

Knowledge: Information that can be learned from reading, listening to an expert, or keenly observ-



ing a situation; often a prerequisite to skill development.

Management: Process of obtaining, deploying, and utilizing a variety of essential resources in support of an organization's objectives.

Management by objectives (MBO): Planning and control technique where a supervisor and their immediate superior agree on goals to be attained and/or standards to be maintained.

Management development: Systematic program for improving knowledge, attitudes, and skills of supervisors and managers.

Management principles: Set of guidelines established for carrying out the management process.

Management process: General sequence of five unique functions; planning, organizing, staffing, directing or activating, and controlling, provided by managers for any organization.

Manager: Individual who plans, organizes, directs, and controls work of others in an organization.

Material Safety Data Sheets (MSDS): Provides information about manufactured chemicals as required by the Hazard Communication Rule (HCR).

Mentor: Knowledgeable, often influential, individual who takes an interest in, and advises, another person concerning that person's career.

Morale: Measure of extent of voluntary cooperation demonstrated by an individual or work group and of the intensity of desire to meet common work goals.

Motivation: Process that impels someone to behave in a certain manner in order to satisfy highly individual needs.

Networking: Informal process of getting to know, and create confidence among others who, through mutual exchange, help advance one's career.

Non-managerial employees: Workers who receive direction from managers, who perform specific, designated tasks, and who are responsible only for their own performance.

Operator: (As related the Underground Service Alert System) Also known as the Facility Owner/Operator – Any person, utility, municipality, authority, political subdivision or other person or entity who owns, operates or controls the operation of an underground line/facility.

Organizing: Deciding who does what work and delegating authority to the appropriate person.

Organization: Structure derived from systematically grouping tasks to be performed and from prescribing formal relationships that strengthen the ability of people to work together more effectively.

Performance appraisal: Formal and systematic evaluation of how well a person is performing their work and fills an appropriate role in the organization.

Penalty: Punishment or forfeiture imposed by management on an employee as discipline.

Personality – An individual's unique way of behaving and interpreting events and actions of others.



PERT Chart: Graphic technique for planning a project in which a large number of tasks must be coordinated by showing the relationship between tasks and critical bottlenecks that may delay progress towards completion.

Policies: Broad guidelines, philosophy, or principles which management establishes, then follows, in support of organizational goals.

Procedures: Methods, prescribed by management, for the proper and consistent forms, sequences, and channels to be followed by individuals and units of an organization.

Productivity – Measure of efficiency that compares operational output value with cost of resources used.

Progressive Discipline: Providing increasingly harsh penalties for substandard performance or broken rules as the condition continues or the infraction is repeated.

Quid pro quo: an equal exchange or substitution; as applied to harassment- when a supervisor threatens to fire or not promote an employee if they do not provide sexual favors in return.

Regulations: Special rules, orders, and controls set forth by management restricting the conduct of units and or individuals within an organization.

Reprimand: Severe expression of disapproval or censure by management of an employee, usually written as well as oral, and retained in an employee's personal file.

Responsibilities: Those duties one is held accountable for.

Responsibility: Duty or obligation to perform a prescribed task or service or attain an objective.

Reverse discrimination: Notion that implementation of affirmative action deprives qualified members of non-protected groups their rightful opportunities.

Satisfaction: State that exists when motivating factors - such as interesting and challenging work, full use of one's capabilities, or recognition for achievement - are provided.

Schedules: Detailed assignments dictating how facilities, equipment, and/or individuals are used, according to times and dates, in accomplishment of organizational objectives.

Sexual Harassment: Unwanted sexual advances, requests for sexual favors or other visual, verbal, or physical conduct of a sexual nature which is conditioned upon an employment benefit, unreasonably interferes with an individuals work performance or creates an offensive work environment.

Skill: The capacity to perform a job related action by blending relevant knowledge and physical or perceptual ability.

Specification: Collection of standardized dimensions and characteristics pertaining to a product, process, or service.

Stereotype: Characterization of an individual on the basis of a standardized, oversimplified view of characteristics believed to be held in common by a group to which the individual is assumed to



belong.

Supervisor: Manager who is in charge of, and coordinates, activities of a group of employees engaged in related activities within a department, section, or unit of an organization.

Suspension: Temporary removal by management of an employee privilege (such as the right to report to work and receive pay for it) until proper actions have been determined and imposed.

Time budget – Charting technique for planning the systematic distribution of a supervisor's time.

Theory X: Negative approach to human relations in which a supervisor presumes most people don't like to work and thus need to be pushed or threatened.

Theory Y: Positive approach to human relations whereby a supervisor presumes that, given meaningful work, most people will try hard to achieve, especially when there is an opportunity to improve their self-regard.

Tolerance: Permissible deviation, or variance, from a standard.

Type A individual: Person characterized by high standards of achievement and an urgency to attain them, who is especially susceptible to stress.

Underground Service Alert (USA): The entity in California that administers the system through which a person can notify owner/operators of lines or facilities of proposed excavations.

Unfair labor practices: Practices engaged in by management or labor unions that are judged by federal labor law to be improper, especially when they interfere with the right to organize or discriminate against labor union activities.

Unity of Command: Principle that each individual should report to only one boss.

Unity of Direction: Principle that there should be a single set of goals and objectives that unites the activities of everyone in an organization.

Variance: Gap, or deviation, between actual performance, condition, or result and a standard or expected performance, condition, or result.

Warning: A reprimand so worded as to give formal notice to an employee that repetition of a particular form of unacceptable behavior will draw a penalty.

Worker's compensation: Financial reparations or awards granted by an employer to an employee who has suffered an on-the-job injury or illness that is judged to have permanently restricted the employee's earning capacity.

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Common Acronyms and Abbreviations

AC Power: alternating current

AC: acre

AC Pipe: Asbestos Concrete Pipe

ADWF: Average Dry Weather Flow

AF: acre-feet

AF: acre-foot (feet)

AFY: acre-foot per year

AMSA: Association of Metropolitan Sewerage Agencies

ANSI: American National Standard Institute

APHA: American Public Health Association

ASCE: American Society of Civil Engineers

ASME: American Society of Mechanical Engineers

ASTM: American Society for Testing and Materials

AWWA: American Water Works Association

BECP: Business Emergency and Contingency Plan

BOD: Biochemical Oxygen Demand

BTU: British thermal unit

C: Celsius

Cal EMA: California Emergency Management Agency

Cal OSHA: California Occupational Safety and Health Act

CalEPA: California Environmental Protection Administration

CCR: California Code of Regulations

CDPH: California Department of Public Health

cf: cubic feet (foot)

CFR: Code of Federal Regulations

cfs: cubic feet per second

CH₄: Methane

CIU: Categorical Industrial User

CM: common mode

CMOM: Capacity Management, Operations, and Maintenance



CPR: Cardiopulmonary Resuscitation
CPU: central processing Unit
CRWA: California Rural Water Association
CSP: confined-space permit
CT: current transformer
CWA: Clean Water Act
CWEA: California Water Environment Association
DOHS: Department of Homeland Security or Department/Division of Occupational Health & Safety
DV/DT: (DV/DT) The change in voltage per change in time.
DWF: dry weather flow
DWR: Department of Water Resources
EIR: Environmental Impact Report
EIS: Environmental Impact Statement
EMF: electromotive force or voltage
EPA: U.S. Environmental Protection Agency
ERP: Emergency Response Plan
F: Fahrenheit
ft: feet (foot)
ft²: square foot
ft³: cubic feet
gal: gallon
GFI: ground fault interrupter
GIS: Geographical Information System
GPD: gallons per day
GPM: gallons per minute
GTAW: gas tungsten arc welding
H₂S: hydrogen sulfide
HCP&ERP: Hazard Communications Program and Emergency Response Plan
hp: horsepower
Hz: Hertz
IIPP: Injury and Illness Prevention Plan
IML: Interface Management Language
K: Kilo, a prefix meaning 1000
KVA: kilovolt amperes



kw: kilowatt
kwh: kilowatt hour
L: liter
lb: pound
LRO: Legally Responsible Official
M: Mega, a metric prefix meaning 1,000,000
m: meter
MA: millamps
MBO: Management by Objectives
MG: million gallons
mg: milligram
mg/L: milligrams per liter
mgd: million gallons per day
min: minute
MIS: Manufacturing Information System
mL: milliliter
MMI: Man Machine Interface
MOP: Manual of Practice
MPN: most probable number
MSDS: Material Safety Data Sheets
N: normal
NEPA: National Environmental Policy Act
NOCA: National Organization for Competency Assurance
NPDES: National Pollutant Discharge Elimination System
NPSH: net positive suction head
NTU: nephelometric turbidity unit(s)
O&M: operation and maintenance
OCT: Operator Certification Test (State of California)
OMR: operations, maintenance, and replacement
OOC: Office of Operator Certification (SWRCB)
OSHA: Occupational Safety and Health Administration/Act
P: pico, a metric prefix meaning one millionth
PLS: Private Lateral Spill
PC: personal computer



pH: potential of hydrogen
PI&D: piping and instrumentation diagram
PLC: Programmable Logic Controller
POTW: Publicly Owned Treatment Works
PPB: parts per billion
PPE: Personal Protective Equipment
PPM: parts per million
prct: percent
psi: pound per square inch
PSIG: pounds per square inch gage
PVC: polyvinyl chloride (pipe)
QA/QC: quality assurance/quality control
RCP: reinforced concrete pipe
RFI: Radio Frequency Interference
RMS: root mean square
RWQCB: Regional Water Quality Control Board (State of California)
SCADA: supervisory control and data acquisition
SCR: semiconductor, or silicon controlled rectifier
sec: second
SI: System Internationale D'Unites (metric units)
SSO: sanitary sewer overflow
SSMP: Sewer System Mangement Plan
SWRCB: (California) State Water Resources Control Board
TAC: Technical Advisory Committee
TCP: Technical Certification Program
TU: turbidity unit
U: micro, a metric prefix meaning one millionth
UPS: uninterruptible power supply
USA: Underground Service Alert
USEPA: United States Environmental Protection Agency
V: volt
VAC: volts of alternating current
VCP: vitrified clay pipe
VFD: variable frequency drive
VOM: volt Ohm meter



- W:** watt
- WAN:** wide area network
- WEF:** Water Environment Federation
- WRP:** water reclamation plant
- WWF:** wet weather flow
- WWTF:** wastewater treatment facility
- WWTP:** wastewater treatment plant (same as POTW)
- yr:** year

