Expected Range of Knowledge for Drinking Water Distribution Exam

	Number of questions by Exam Grade				
Content Category	**D1**	**D2**	**D3**	**D4**	**D5**
Disinfection	15	20	20	15	10
Distribution System Design / Hydraulics	20	20	15	10	10
Equipment Operation / Maintenance / Inspections	20	20	25	20	15
Drinking Water Regulations / Management / Safety	15	10	15	35	45
Water Mains and Piping	20	20	15	5	5
Water Quality / Water Source	10	10	10	15	15

Disinfection

Water Main Disinfection
Well Disinfection
Disinfectant By-Products
Chloramination
Chlorine Curve Chemistry
Storage Reservoir Disinfection
Types of Disinfectants

Distribution System Design / Hydraulics

System Layout
Storage Facilities
Service Connections
Systems Map
Cross-Connection and Backflow Devices
Assess System Demand
Flow Rates and Velocity
Head Loss
Cavitation
Water Hammer
Water Pressure and Volume
Static and Dynamic Pressure

Equipment Operation / Maintenance / Inspections

Valves
Water Meters
Hydrants
Chemical Feeders
Equipment Installation and Repair
Troubleshoot and Repair Pumps and Motors
Inspection of Water Mains, Piping, Storage Tanks
Corrosion
In-Line Sensors
Power Generators
SCADA
Pump Types, Uses, and Sizes
Water Horsepower
Wells (New and Abandoned)

Drinking Water Regulations / Management / Safety

Disinfection-By-Product Rule
Lead and Copper Rule
MCLs
Public Notification
Administer Compliance, Budgets
Monitoring and Sampling Requirements
Operator Certification Regulations
Safe Drinking Water Act
Total Coliform Rule
Emergency Response Planning
Future Planning
Maintenance Plan
Safety Plan
Water Conservation Planning
Water Rates

Expected Range of Knowledge for Drinking Water Distribution Exam

Water Mains and Pumping

Cleaning and Maintenance	Joints and Fittings	Service Line Installation
Excavation	Leak Detection and Repair	
Installation and Repair	Pipe Selection	

Water Quality / Water Sources

Coliform Group	Unidirectional Flushing	Sanitary Survey
Corrosivity	Waterborne Diseases	
Heterotrophic Bacteria	Groundwater and Wells	
Organic and Inorganic Compounds		
pH, Conductivity, Hardness, and Turbidity		

The tables below list specific objectives in each content category. The specific exam grades where these objectives are included are also provided below.

Disinfection

Water Main Disinfection

D1 - D5	Knowledge of water main disinfectant techniques
D1 - D5	Knowledge of dechlorination techniques
D1 - D5	Ability to apply disinfectant
D1 - D5	Knowledge of AWWA disinfection standards for water mains

Well Disinfection

D1 - D5	Knowledge of contamination sources in a well
D1 - D5	Ability to calculate a disinfectant dosage
D1 - D5	Knowledge of well disinfection techniques
D1 - D5	Knowledge of water depth measurement techniques
D1 - D5	Knowledge of AWWA disinfection standards for wells
D1 - D5	Ability to measure the water depth in a well
D1 - D5	Ability to calculate the volume of a well

Storage Reservoir Disinfection

D1 - D5	Knowledge of water storage contamination sources
D1 - D5	Ability to calculate the volume of a storage reservoir
D1 - D5	Knowledge of storage reservoir disinfection techniques
D1 - D5	Knowledge of AWWA disinfection standards for storage facilities
D1 - D5	Ability to calculate a disinfectant dosage
D2 - D5	Ability to choose the proper disinfectant technique
D2 - D5	Ability to calculate the surface area of the interior walls of a storage reservoir
D3 - D5	Ability to calculate CT

Disinfectant By-Products

D2 - D5	Knowledge of the causes of DBPs
D3 - D5	Knowledge of DBP reduction methods
D3 - D5	Knowledge of DBP formation
D3 - D5	Knowledge of DBP compounds
D3 - D5	Ability to recognize abnormal levels of DBPs in the water distribution system

Chloramination

D1 - D5	Ability to measure total chlorine
D2 - D5	Knowledge of the chlorine curve
D2 - D5	Knowledge of advantages/disadvantages of chloramination
D2 - D5	Knowledge of chloramine compounds
D2 - D5	Ability to calculate chlorine/ammonia ratio for chloramination

Chlorine Curve Chemistry

D2 - D5	Knowledge of the definition of breakpoint chlorination
D2 - D5	Knowledge of the chlorine curve
D2 - D5	Ability to recognize when breakpoint has been met

Types of Disinfectants

D1 - D5	Knowledge of the purpose of disinfection
D1 - D5	Knowledge of contact time
D1 - D5	Knowledge of causes of chlorine demand
D1 - D5	Ability to monitor and interpret chlorine residual
D1 - D5	Ability to calculate a dosage
D2 - D5	Knowledge of disinfectant types and characteristics
D2 - D5	Knowledge of factors affecting chlorine disinfection
D2 - D5	Knowledge of chlorine analysis techniques
D3 - D5	Knowledge of chlorine chemistry

Distribution System Design / Hydraulics

Assess System Demand

D1 - D5	Knowledge of unit conversions
D2 - D5	Knowledge of the terms, “peak demand,” “peak hour demand,” “maximum daily demand,” and “per-capita demand”

Cross-Connection and Backflow Devices

D1 - D5	Knowledge of conditions that cause backflow
D1 - D5	Knowledge of available backflow prevention methods
D1 - D5	Knowledge of “back-pressure” and “back-siphonage” conditions

Expected Range of Knowledge for Drinking Water Distribution Exam

D1 - D5	Ability to recognize a potential backflow hazard
D1 - D5	Ability to recognize a cross-connection

Service Connections

D1 - D5	Knowledge of service connection materials and fittings
D1 - D5	Ability to tap a water main
D2 - D5	Knowledge of recordkeeping requirements

Storage Facilities

D1 - D5	Ability to calculate the volume of a storage facility
D1 - D5	Ability to calculate flow rates for a storage facility
D2 - D5	Knowledge of the types of storage facilities and their applications
D2 - D5	Knowledge of storage facility corrosion control methods
D2 - D5	Knowledge of storage facility components
D2 - D5	Ability to drain, clean, and disinfect a storage facility

System Layout

D1 - D5	Knowledge of “grid,” “tree,” “arterial,” and “dead end” water systems
D2 - D5	Ability to differentiate between a “trunk” line and a “transmission” line
D4 - D5	Ability to calculate a hydraulic gradient

System Maps

D1 - D5	Knowledge of pressure/elevation relationships
D2 - D5	Knowledge of map types
D2 - D5	Ability to interpret map symbols
D2 - D5	Ability to convert a scale to actual distance

Flow Rates and Velocity

D1 - D5	Ability to convert units of volume, area, and time
D1 - D5	Ability to calculate the volume of a pipe
D1 - D5	Ability to calculate the area of a pipe cross-section
D1 - D5	Ability to calculate a flow rate
D2 - D5	Ability to calculate water velocity

Head Loss

D2 - D5	Knowledge of the relationship between head loss and friction
D3 - D5	Knowledge of the effect of corrosion on head loss

Cavitation

D2 - D5	Knowledge of the causes of cavitation

D2 - D5 Ability to recognize the signs of cavitation

Water Hammer

D1 - D5 Knowledge of water hammer reduction techniques
D1 - D5 Knowledge of the definition of water hammer
D1 - D5 Knowledge of the causes of water hammer
D1 - D5 Ability to calculate the surface area of a valve face
D2 - D5 Ability to calculate total force on a valve

Water Pressure and Volume

D1 - D5 Ability to convert units of volume, pressure and area
D1 - D5 Ability to calculate the volume of a cylinder, rectangle, and square

Static and Dynamic Pressure

D1 - D5 Knowledge of the relationship between water velocity and water pressure
D1 - D5 Ability to recognize abnormal pressure readings (too high or too low)
D1 - D5 Ability to read and interpret a pressure gauge
D1 - D5 Ability to convert pressure to feet of head

Equipment Operation / Maintenance / Inspections

Valves

D1 - D5 Knowledge of proper valve installation
D1 - D5 Knowledge of valve types and applications
D1 - D5 Knowledge of the principles of operation of valves
D1 - D5 Knowledge of pressure regulating valve maintenance
D1 - D5 Ability to recognize a malfunctioning valve
D2 - D5 Knowledge of pressure ratings

Water Meters

D1 - D5 Knowledge of water meter types and purposes
D1 - D5 Ability to convert water units
D1 - D5 Ability to choose the correct meter size
D2 - D5 Knowledge of mechanical parts of water meters

Hydrants

D1 - D5 Knowledge of thrust blocks
D1 - D5 Knowledge of pressure requirements
D1 - D5 Knowledge of mechanical parts of hydrants
D1 - D5 Knowledge of hydrant types
D1 - D5 Ability to flush using a hydrant

Expected Range of Knowledge for Drinking Water Distribution Exam

Chemical Feeders

D1 - D5	Ability to read a graduated cylinder
D1 - D5	Ability to calculate a dosage
D2 - D5	Knowledge of chemical feeder types
D2 - D5	Knowledge of chemical feeder components
D2 - D5	Ability to troubleshoot a chemical feeder

Corrosion

D2 - D5	Knowledge of type and applications of cathodic protection devices
D3 - D5	Knowledge of the galvanic series
D3 - D5	Knowledge of principles of operation of cathodic protection devices

In-Line Sensors

D2 - D5	Knowledge of required reagents and standards
D2 - D5	Knowledge of analysis methods
D2 - D5	Ability to recognize normal operation of in-line sensors

Power Generators

D1 - D5	Knowledge of start-up procedures
D1 - D5	Knowledge of basic operation
D4 - D5	Knowledge of power requirements (e.g. efficiency)

SCADA

D2 - D5	Knowledge of the components of a SCADA system
D2 - D5	Knowledge of communication techniques
D2 - D5	Ability to interpret SCADA information

Pump Types, Uses, and Sizes

D1 - D5	Knowledge of pump types
D2 - D5	Knowledge of operational principles of a water pump
D3 - D5	Ability to match pump type to application
D3 - D5	Ability to interpret a pump curve

Troubleshoot and Repair Pumps and Motors

D1 - D5	Ability to recognize abnormal pump operating conditions
D2 - D5	Knowledge of the mechanical components of pumps and motors
D2 - D5	Knowledge of pump maintenance procedures
D2 - D5	Ability to repair and replace pump and motor system components
D3 - D5	Knowledge of recordkeeping requirements

D3 - D5	Knowledge of when to “MEG” a motor

Water Horsepower

D3 - D5	Ability to calculate pump efficiency
D3 - D5	Ability to calculate brake-horsepower
D4 - D5	Ability to calculate the cost of pumping water

Inspection of Water Mains and Piping

D1 - D5	Knowledge of proper backfill procedures and compaction
D1 - D5	Knowledge of proper bedding techniques
D1 - D5	Knowledge of pipe connectors and applications
D1 - D5	Knowledge of compatible materials
D1 - D5	Ability to recognize faulty or damaged pipe
D1 - D5	Ability to recognize abnormal operating conditions
D2 - D5	Knowledge of proper thrust restraint
D2 - D5	Knowledge of proper disinfection techniques
D2 - D5	Knowledge of allowable leak loss

Inspection of Storage Tanks

D1 - D5	Knowledge of security procedures/measures
D1 - D5	Knowledge of safety equipment requirements
D3 - D5	Knowledge of storage tank corrosion control measures

Inspection of Equipment Installation and Repair

D1 - D5	Knowledge of proper valve installation
D1 - D5	Knowledge of proper hydrant installation
D1 - D5	Knowledge of hydrant valve operation/testing
D2 - D5	Knowledge of thrust restraint requirements
D2 - D5	Knowledge of packing gland settings
D3 - D5	Knowledge of proper pump alignment
D3 - D5	Knowledge of proper phase balance

Inspection of Wells (New and Abandoned)

D1 - D5	Ability to calculate draw down
D2 - D5	Knowledge of proper installation of a sanitary seal on a well
D3 - D5	Ability to calculate specific yield
D4 - D5	Knowledge of well abandonment procedures and permit requirements
D4 - D5	Knowledge of proper gravel packing and screen depth
D5	Knowledge of permit requirements

Expected Range of Knowledge for Drinking Water Distribution Exam

Drinking Water Regulations / Management / Safety

Disinfection By-Product Rule

- D2 - D5 Knowledge of Disinfection By-Product Rule sampling requirements
- D3 - D5 Knowledge of Disinfection By-Product Rule reporting requirements
- D3 - D5 Knowledge of Disinfection By-Product Rule MCL requirements

Lead and Copper Rule

- D1 - D5 Ability to take a lead and copper sample
- D3 - D5 Knowledge of lead and copper sampling requirements
- D3 - D5 Knowledge of lead and copper rule reporting requirements
- D4 - D5 Ability to recognize a lead and copper rule violation

Maximum Contaminant Levels (MCL)

- D1 - D5 Knowledge of the definition of MCL
- D2 - D5 Knowledge of maximum disinfectant residual level for chlorine
- D2 - D5 Ability to differentiate between a primary and secondary MCL
- D2 - D5 Ability to recognize MCL violations

Monitoring and Sampling Requirements

- D1 - D5 Ability to read a sample siting plan
- D1 - D5 Knowledge of water sampling techniques for bacteriological, organic, and inorganic constituents
- D1 - D5 Knowledge of holding times (e.g. preservatives)

Operator Certification Regulations

- D1 - D5 Knowledge of certification requirements

Public Notification

- D1 - D5 Knowledge of acute violations
- D1 - D5 Knowledge of when public notification is required
- D4 - D5 Knowledge of required language to use
- D4 - D5 Knowledge of notification paths (e.g. newspaper, electronic)

Safe Drinking Water Act (SDWA)

- D1 - D5 Knowledge of the purpose of the SDWA
- D1 - D5 Knowledge of the major components of the SDWA
- D2 - D5 Knowledge of reporting and recordkeeping requirements
- D3 - D5 Knowledge of non-compliance penalties

Total Coliform Rule

- D1 - D5 Knowledge of Total Coliform Rule sampling requirements

Expected Range of Knowledge for Drinking Water Distribution Exam

D1 - D5	Knowledge of Total Coliform Rule reporting requirements

Administer Compliance, Budgets

D1 - D5	Knowledge of OSHA/Cal-OSHA safety regulations
D1 - D5	Knowledge of CDPH Water Quality regulations
D3 - D5	Ability to calculate the cost of water production
D5	Knowledge of RWQCB discharge requirements
D5	Knowledge of Air Quality Management regulations
D5	Knowledge of the components of a budget (e.g. revenues, expenditures, risk management, insurance costs, depreciation)
D5	Knowledge of O&M budget components (e.g. labor, professional services, supplies, energy, water, capital improvement)

Emergency Response Planning

D1 - D5	Knowledge of the components of the Emergency Response Plan
D1 - D5	Knowledge of system pressure zones
D2 - D5	Knowledge of AWWA disinfection standards
D3 - D5	Knowledge of the vulnerability assessment
D3 - D5	Knowledge of public notification requirements
D3 - D5	Ability to train personnel on emergency response procedures
D3 - D5	Ability to perform damage assessment and recovery planning

Future Planning

D4 - D5	Knowledge of long-term water availability
D4 - D5	Knowledge of capital improvement/capital replacement requirements
D4 - D5	Ability to estimate future water needs

Maintenance Plan

D1 - D5	Knowledge of predictive, preventative, and corrective maintenance
D1 - D5	Knowledge of maintenance recordkeeping
D2 - D5	Knowledge of the fire hydrant testing program
D2 - D5	Knowledge of valve exercise program

Safety Plan

D1 - D5	Knowledge of the elements of a safety program (e.g. policy statement, training, promotion, accident investigation, reporting)
D1 - D5	Knowledge of safety regulation requirements (e.g. IIPP)
D3 - D5	Knowledge of recordkeeping/reporting requirements to OSHA
D4 - D5	Ability to develop and implement a safety plan

Water Conservation Planning

D3 - D5	Knowledge of energy conservation methods
D4 - D5	Ability to conduct a water audit
D4 - D5	Ability to calculate water production costs
D4 - D5	Ability to calculate a water loss rate

Water Rates

D5	Knowledge of water use projection methods
D5	Knowledge of water rate structures, water rate setting methods
D5	Knowledge of local water usage patterns
D5	Ability to calculate annual expenditures

Safety

D1 - D5	Knowledge of trenching safety equipment and procedures
D1 - D5	Knowledge of traffic control procedures
D1 - D5	Knowledge of personal safety equipment and procedures
D1 - D5	Knowledge of hazardous material safety equipment and handling
D1 - D5	Knowledge of fire safety equipment and procedures
D1 - D5	Knowledge of electrical safety equipment and procedures
D1 - D5	Knowledge of confined space safety equipment and procedures
D1 - D5	Knowledge of chemical handling safety equipment and procedures
D1 - D5	Knowledge of AC pipe handling procedures
D1 - D5	Knowledge of the relapse cycle
D1 - D5	Ability to recognize a confined space

Water Mains and Piping

Cleaning and Maintenance

D1 - D5	Knowledge of proper flushing procedures
D1 - D5	Knowledge of notification requirements
D1 - D5	Ability to set up a temporary service line
D2 - D5	Knowledge of the causes and effects of tuberculation
D2 - D5	Knowledge of pipe cleaning procedures
D3 - D5	Ability to recognize tuberculation
D3 - D5	Ability to choose the proper cleaning technique

Excavation, Installation, and Repair

D1 - D5	Knowledge of bedding techniques
D1 - D5	Knowledge of proper backfill techniques

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D1 - D5	Knowledge of notification requirements
D1 - D5	Knowledge of excavating techniques
D1 - D5	Knowledge of compaction tools and methods
D1 - D5	Knowledge of Cal-OSHA trenching and shoring requirements
D1 - D5	Ability to operate a dewatering pump
D1 - D5	Ability to connect water pipe
D1 - D5	Ability to calculate the volume of a trench
D2 - D5	Knowledge of dewatering techniques
D2 - D5	Ability to identify different soil types

Joints and Fittings

D1 - D5	Knowledge of proper joints and fitting applications
D1 - D5	Knowledge of pipe fitting and joining methods
D2 - D5	Knowledge of proper thrust block uses
D2 - D5	Ability to choose the correct type of joint
D2 - D5	Ability to calculate thrust block size

Leak Detection and Repair

D1 - D5	Knowledge of pipe locating methods
D2 - D5	Knowledge of leak detection methods
D2 - D5	Knowledge of factors affecting leak detection

Pipe Selection

D1 - D5	Knowledge of pipe material and applications
D1 - D5	Knowledge of pipe material compatibility
D2 - D5	Knowledge of advantages/disadvantages of pipe materials
D2 - D5	Knowledge of C-Factor
D2 - D5	Ability to calculate the velocity of water
D2 - D5	Ability to calculate pipe capacity
D3 - D5	Knowledge of flow demand requirements

Service Line Installation

D1 - D5	Knowledge of material compatibility
D1 - D5	Ability to flush a service line
D1 - D5	Ability to differentiate pipe tap size
D1 - D5	Ability to differentiate meter size
D1 - D5	Ability to calculate pipe volumes
D2 - D5	Knowledge of tapping tools/equipment
D2 - D5	Knowledge of tapping methods

Expected Range of Knowledge for Drinking Water Distribution Exam

Water Quality / Water Sources

Coliform Group

D1 - D5	Knowledge of the definition of pathogenic organisms
D1 - D5	Knowledge of coliform bacteria types
D1 - D5	Knowledge of coliform analysis methods
D1 - D5	Ability to interpret coliform test results
D2 - D5	Knowledge of the use of coliform as a surrogate

Determination of Corrosivity

D2 - D5	Ability to recognize corrosive conditions in distribution systems
D2 - D5	Knowledge of the effect of corrosion in a distribution system
D2 - D5	Knowledge of the causes of corrosion in a distribution system
D3 - D5	Knowledge of the relationship between corrosion and lead/copper concentrations
D3 - D5	Knowledge of the Langelier Index
D3 - D5	Knowledge of corrosion control techniques
D4 - D5	Ability to interpret a Langelier Index

Heterotrophic Bacteria

D2 - D5	Knowledge of the effects of heterotrophic bacteria in a distribution system
D2 - D5	Knowledge of heterotrophic bacteria

Organic and Inorganic Contaminants

D1 - D5	Knowledge of the impacts of high nitrate concentrations in a distribution system
D2 - D5	Knowledge of nitrate formation in a distribution system
D3 - D5	Knowledge of sources of organic contaminants in a distribution system
D3 - D5	Knowledge of sources of inorganic contaminants in a distribution system
D3 - D5	Knowledge of common organic contaminant compounds
D3 - D5	Knowledge of common inorganic contaminant compounds

pH, Conductivity, Hardness, and Turbidity

D1 - D5	Knowledge of the meaning of high levels of turbidity in a distribution system
D1 - D5	Knowledge of normal pH range in drinking water
D1 - D5	Ability to recognize abnormal turbidity levels in a distribution system
D1 - D5	Ability to recognize abnormal pH levels of water in a distribution system
D2 - D5	Knowledge of the effects of hardness in a distribution system
D2 - D5	Knowledge of the effects of abnormal pH levels in a distribution system

Unidirectional Flushing

D1 - D5	Knowledge of the impacts of flushing on a distribution system
D1 - D5	Knowledge of proper flushing velocities

D1 - D5	Knowledge of equipment used for flushing
D2 - D5	Knowledge of flushing techniques
D2 - D5	Ability to recognize when flushing is required
D2 - D5	Ability to calculate a water velocity
D3 - D5	Knowledge of permit requirements for flushing

Waterborne Diseases

D2 - D5	Knowledge of potential waterborne diseases
D2 - D5	Ability to distinguish between presumptive and confirmed results

Groundwater and Wells

D1 - D5	Knowledge of the hydrologic cycle
D1 - D5	Ability to measure well depth
D2 - D5	Knowledge of zone of influence
D2 - D5	Knowledge of well protection
D2 - D5	Knowledge of well components and terms
D2 - D5	Knowledge of water table fluctuations
D2 - D5	Knowledge of static and pumping water level
D2 - D5	Knowledge of recovery time
D2 - D5	Knowledge of cone of depression
D2 - D5	Ability to recognize potential sources of contamination
D2 - D5	Ability to convert a pressure reading to depth of water
D3 - D5	Knowledge of well location requirements
D3 - D5	Knowledge of the chemical components of groundwater
D4 - D5	Knowledge of the characteristics of aquifers

Sanitary Survey

D1 - D5	Ability to recognize potential sources of contamination
D4 - D5	Knowledge of sanitary survey requirements

Water Distribution Exam Math

D1 - D5	Ability to convert water units
D1 - D5	Ability to convert units of volume, area, pressure, and time
D1 - D5	Ability to convert pressure to feet of head
D1 - D5	Ability to calculate a disinfectant dosage
D1 - D5	Ability to measure the water depth in a well
D1 - D5	Ability to calculate the well draw down
D1 - D5	Ability to calculate the volume of a cylinder, rectangle, and square
D1 - D5	Ability to calculate the volume of a well, storage reservoir, pipe, trench
D1 - D5	Ability to calculate flow rates

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D1 - D5	Ability to calculate the area of a pipe cross-section
D1 - D5	Ability to calculate the surface area of a valve face
D2 - D5	Ability to calculate total force on a valve
D2 - D5	Ability to calculate water velocity
D2 - D5	Ability to calculate pipe capacity
D2 - D5	Ability to calculate the surface area of the interior walls of a storage reservoir
D2 - D5	Ability to convert a scale to actual distance
D2 - D5	Ability to convert a pressure reading to depth of water
D2 - D5	Ability to calculate chlorine/ammonia ratio for chloramination
D2 - D5	Ability to calculate thrust block size
D3 - D5	Ability to calculate specific yield of a well
D3 - D5	Ability to calculate CT
D3 - D5	Ability to calculate pump efficiency
D3 - D5	Ability to calculate brake-horsepower
D3 - D5	Ability to calculate the cost of water production
D4 – D5	Ability to calculate the cost of pumping water
D4 – D5	Ability to estimate future water needs
D4 – D5	Ability to calculate the hydraulic gradient
D4 – D5	Ability to calculate water production costs
D4 – D5	Ability to calculate a water loss rate
D5	Ability to calculate annual expenditures