Water Distribution Exams
Expected Range of Knowledge

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

Drinking Water Regulations/Management / Safety

Equipment Operation / Maintenance / Inspections

Water Mains and Piping
Cleaning and Maintenance, Excavation, Installation, and Repair, Joints and Fittings, Leak Detection and Repair, Pipe Selection, Service Line Installation

Water Quality / Water Sources
Coliform Group, Corrosivity, Heterotrophic Bacteria, Organic and Inorganic Contaminants, pH, Conductivity, Hardness, and Turbidity, Unidirectional Flushing, Waterborne Diseases, Groundwater, Wells, Sanitary Survey
(Items marked “D1-D5” may be on the D1 - D5 exams)
(Items marked “D2-D5” may be on the D2 - D5 exams but not on the D1 exam)

**Disinfection**

**Water Main Disinfection**
- **D1-D5** Knowledge of water main disinfectant techniques
- **D1-D5** Knowledge of de-chlorination 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 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
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 record keeping 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 the 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

Drinking Water Regulations / Management / Safety

Disinfection-By-Product Rule
D2-D5 Knowledge of the Disinfectant By-Product Rule sampling requirements
D3-D5 Knowledge of Disinfectant By-Product Rule reporting requirements
D3-D5 Knowledge of Disinfectant 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
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
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, preventive, and corrective maintenance
D1-D5 Knowledge of maintenance record keeping
D2-D5 Knowledge of 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 record keeping / 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 procedure
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

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 meter

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

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 record keeping 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 or 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

**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 affects 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 procedures
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 material
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

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 the distribution systems
D2-D5 Knowledge of the effect of corrosion in a distribution system
D2-D5 Knowledge of the causes of corrosion in a water 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 the distribution system
D2-D5 Knowledge of nitrate formation in the 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 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 effect of abnormal pH levels in the distribution system

Unidirectional Flushing
D1-D5 Knowledge of the impacts of flushing on a water 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/ 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 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 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  
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