Storage Facilities, Pipes, and Hydrants

Water Distribution Operator Certification Training

NEVADA RURAL WATER ASSOCIATION

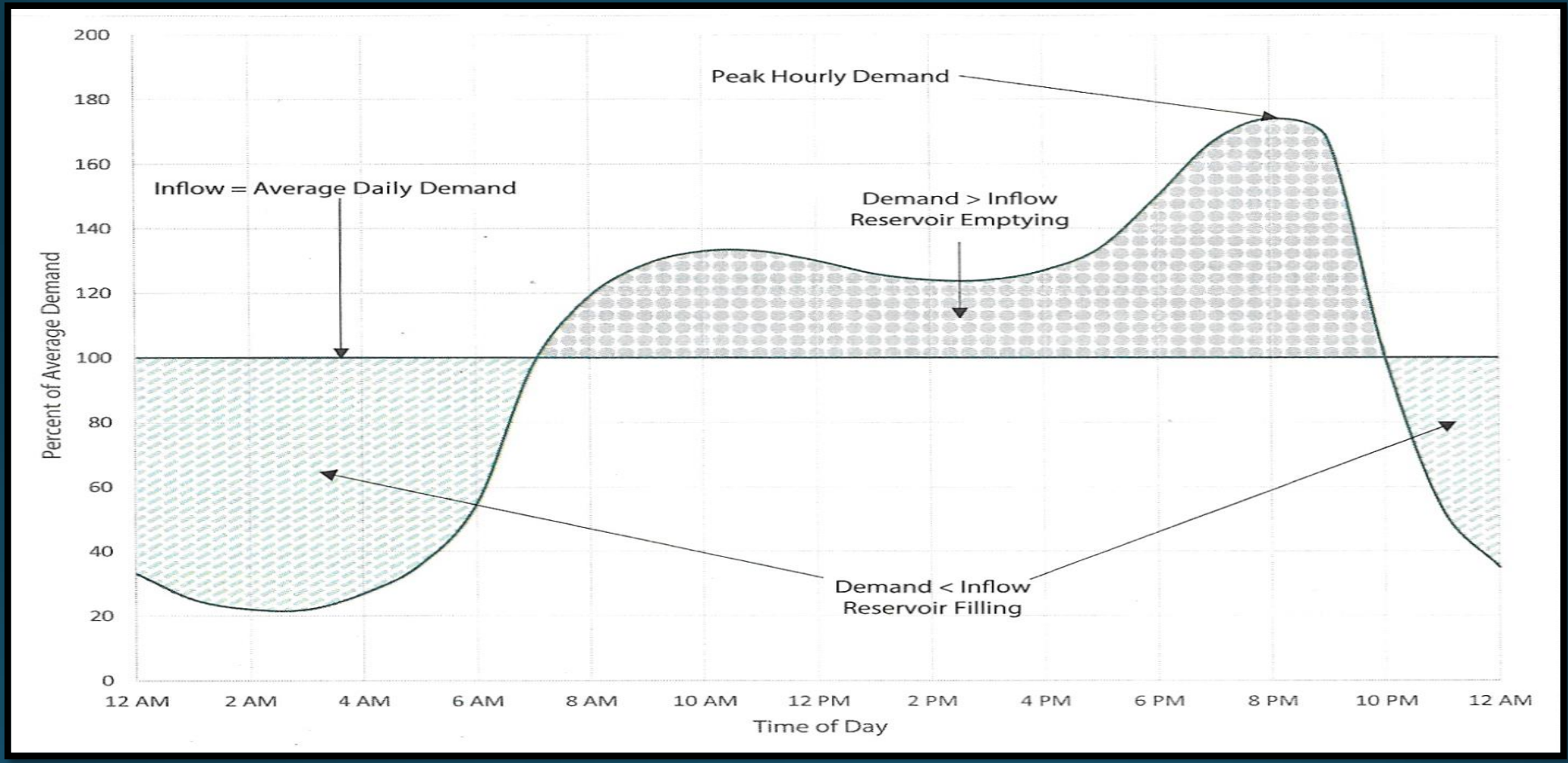
Storage Facilities, Pipes, and Conveyances

Storage Facilities, Pipes, and Conveyances

Picture Courtesy of Superior Tank

Water Storage Reservoirs

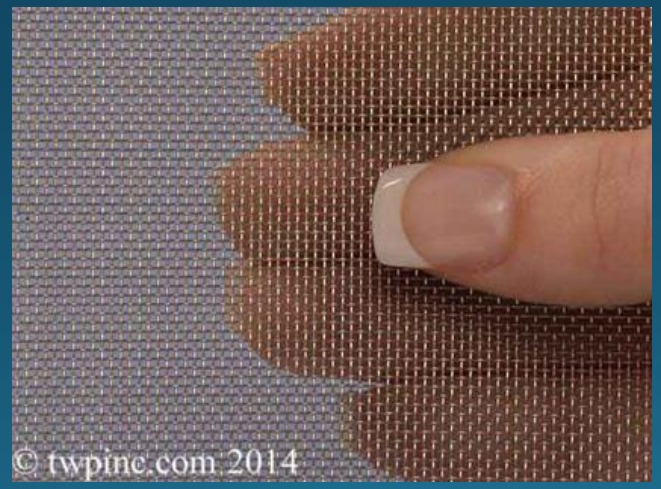
Provides adequate water to the water system during average and peak demands.

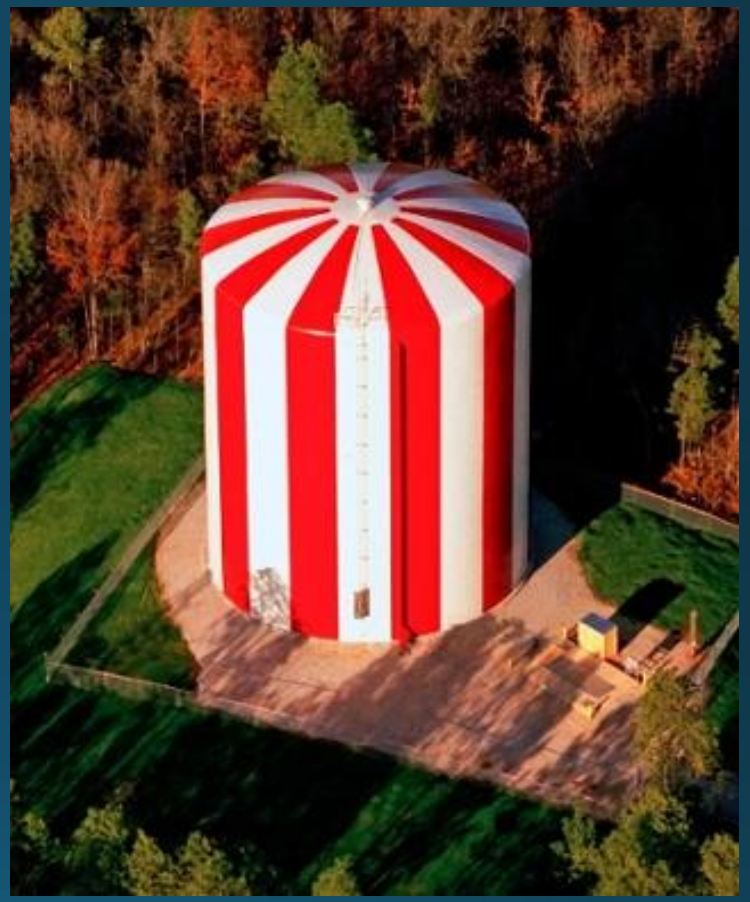


Picture Courtesy of Sacramento State, Water Distribution System Operation and Maintenance, Seventh Ed. pg.40

Water Storage Tanks

- Must be covered to prevent algae and bacterial growth (per SDWA)
- Most susceptible to degradation from external sources
- Must have overflow protected by:
  - Spring loaded flapper
  - #24 stainless mesh
  - Check Valve
- Reserve storage
- Fire protection!!!





Stand Pipe

- A high vertical pipe or reservoir that is used to secure a uniform pressure in a water-supply system
- Height greater than diameter.
- Increased head pressure for flatter topography
- Maintain minimum of 20 psi at all times

- Pressure in Pounds Per Square Inch, PSI

  1PSI=2.31ft

  1ft=.433PSI

Stand Pipe

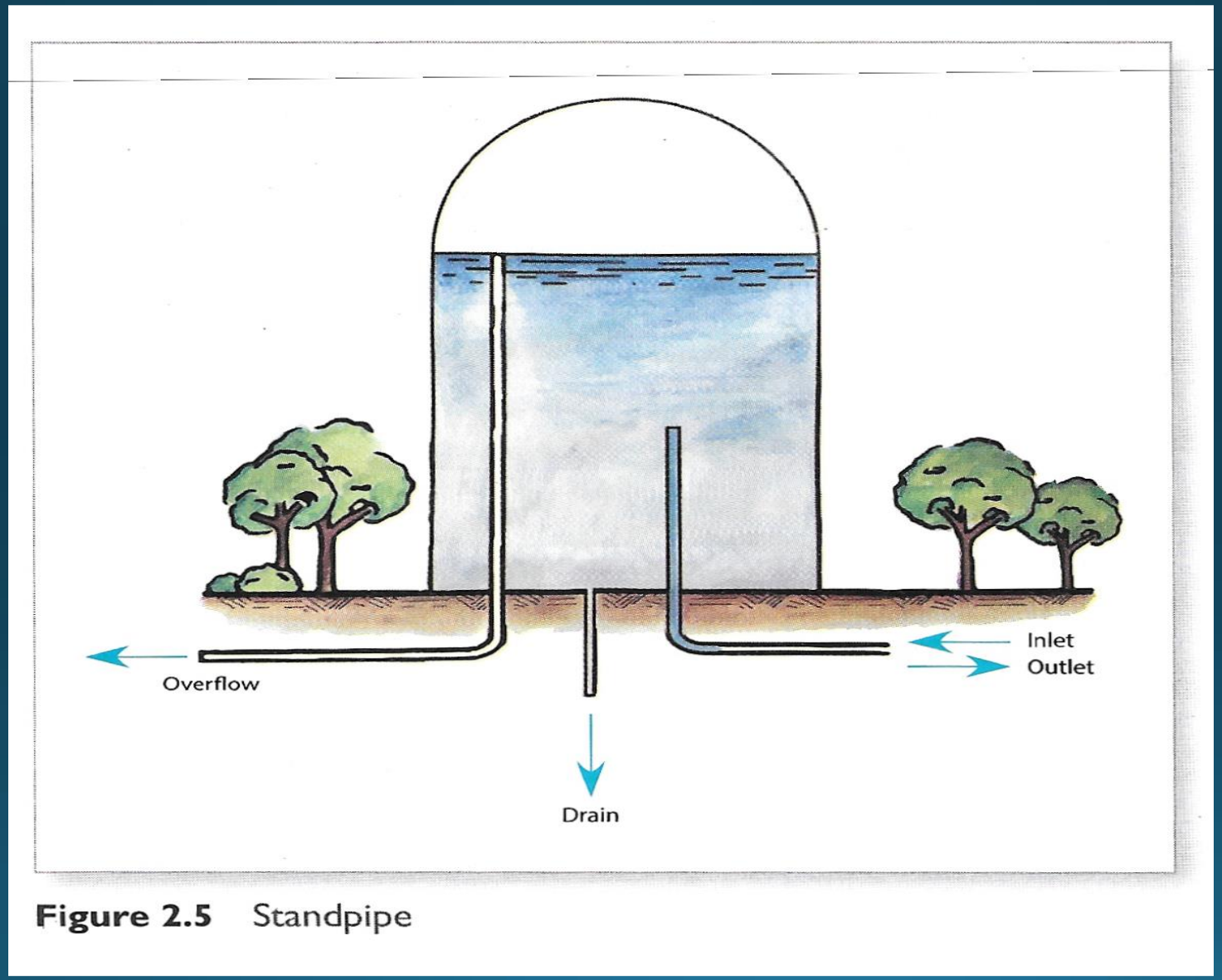
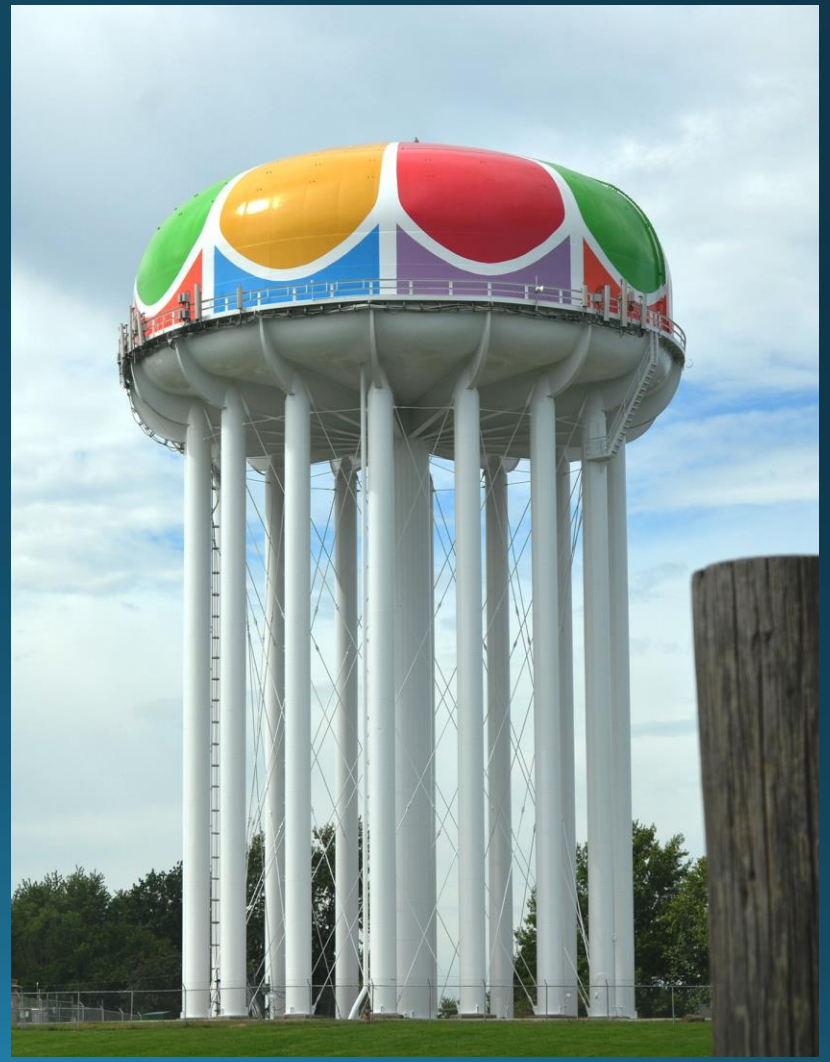


Figure 2.5 Standpipe

Picture Courtesy of Sacramento State, Water Distribution System Operation and Maintenance, Seventh Ed. pg.40

Water Tower

Provides adequate pressures throughout the water systems



Water Tower

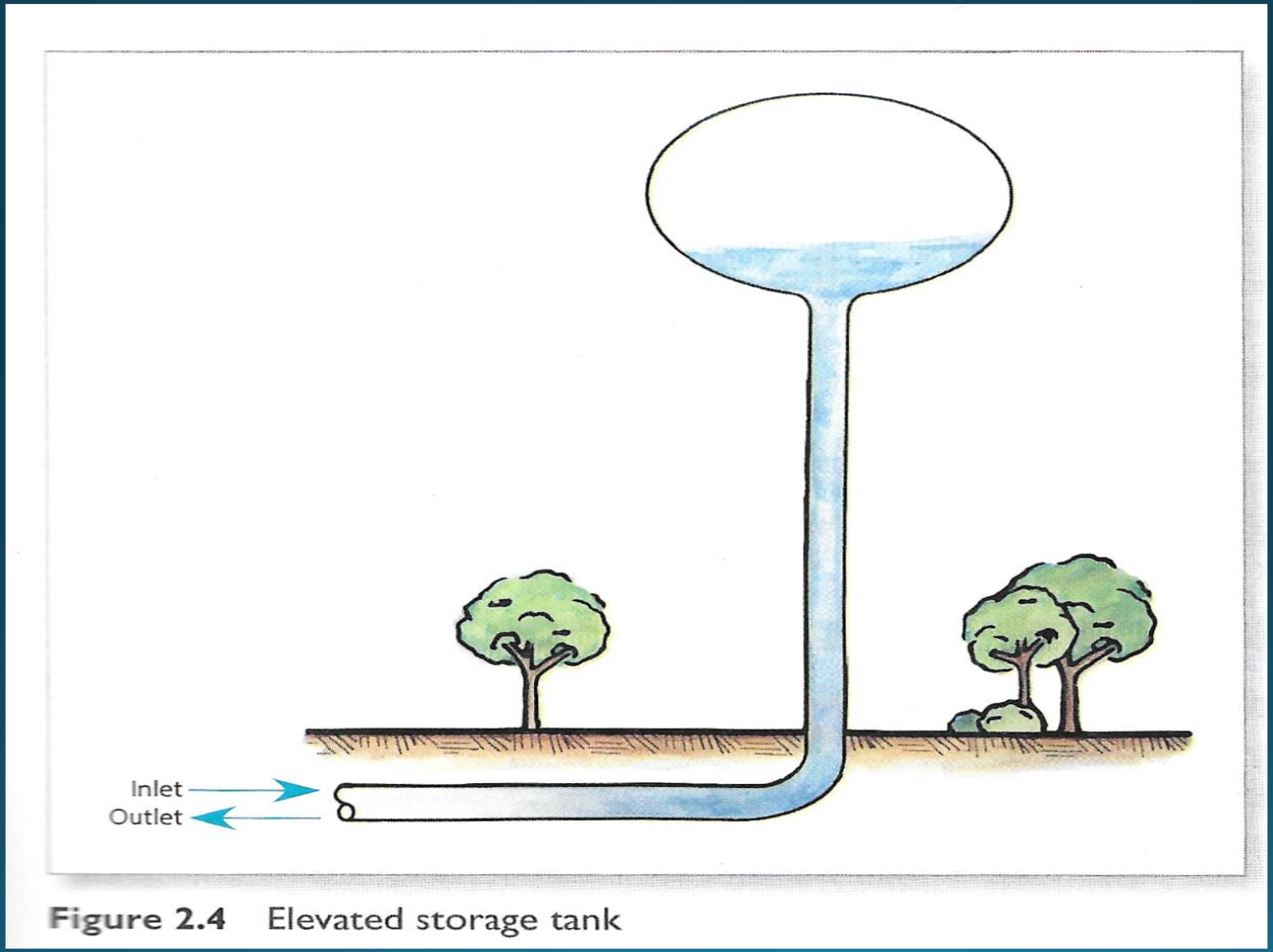


Figure 2.4 Elevated storage tank

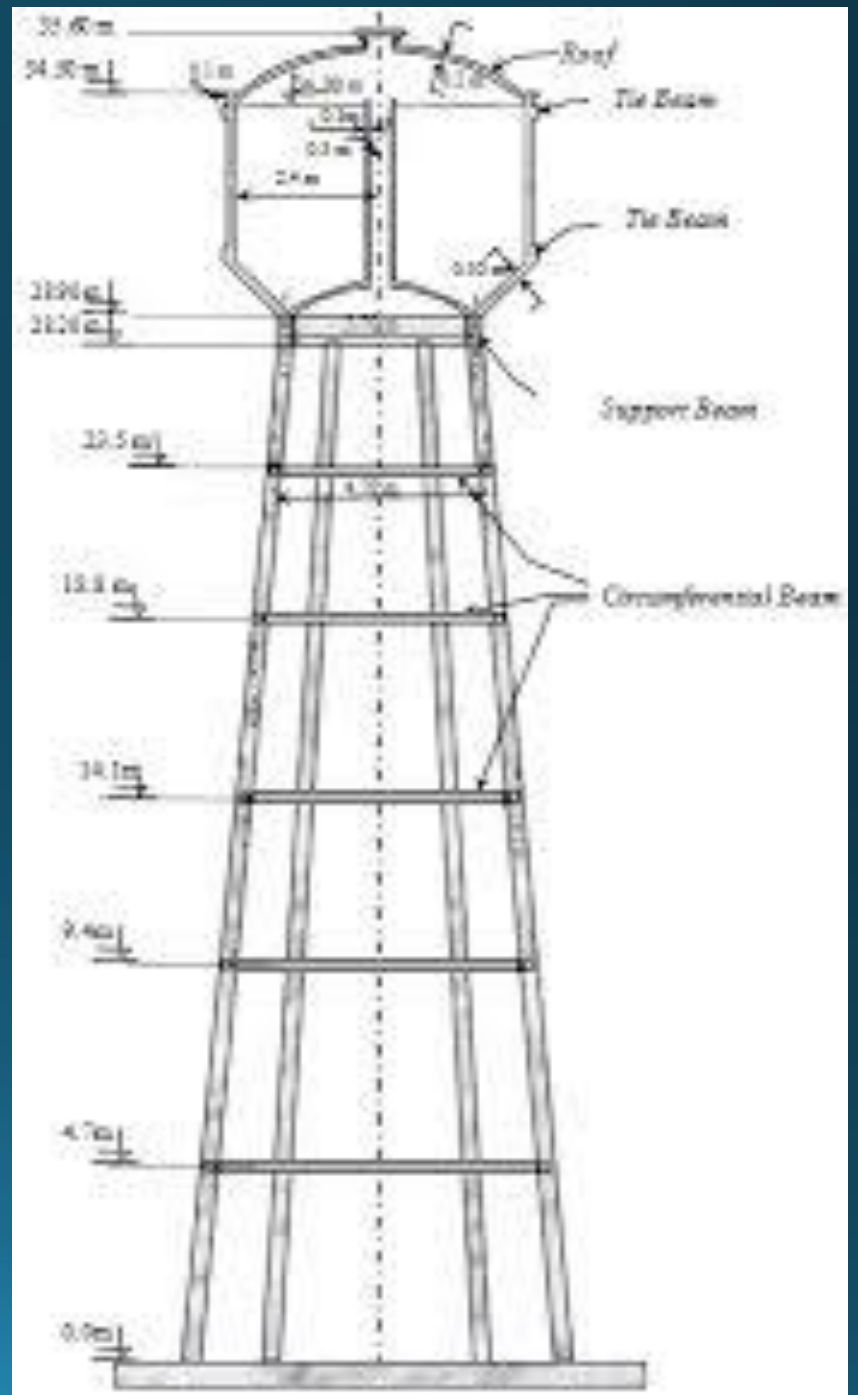
Picture Courtesy of Sacramento State, Water Distribution System Operation and Maintenance, Seventh Ed. pg.40


LULING
GAFFNEY
GAFFNEY

Water Storage Reservoirs

Elevated Storage Reservoirs

Found in flat land areas to produce pressure through elevation.



Water Storage Reservoir

Surge protection

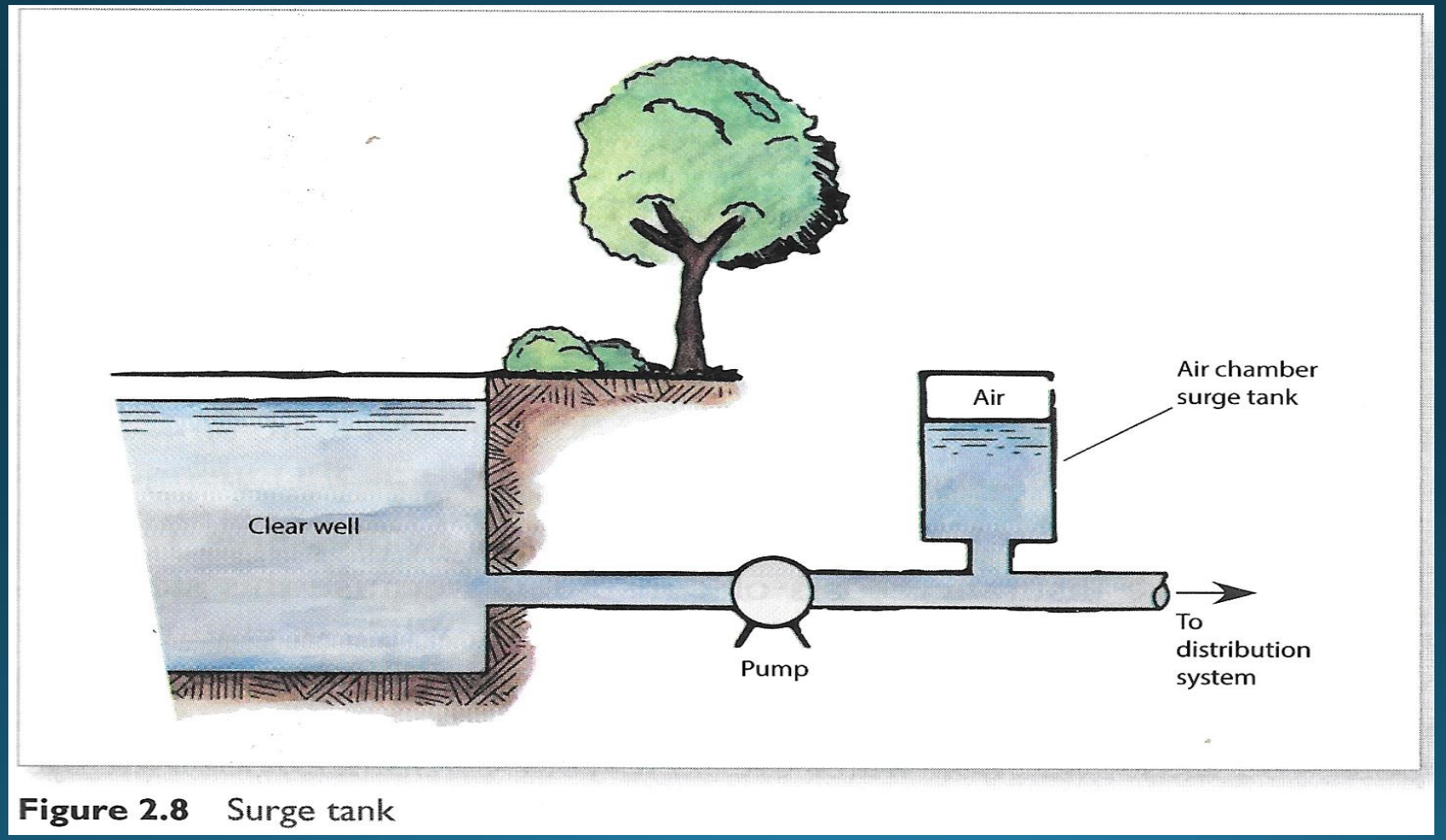


Figure 2.8 Surge tank

Picture Courtesy of Sacramento State, Water Distribution System Operation and Maintenance, Seventh Ed. pg.40

Clear Well

- Store Finished Water
- Typically Underground
- Chlorine Contact Time

Detention Time = Volume/Flow *(must be compatible units)*

CT Calculation =
(Disinfectant Residual Concentration, mg/L)(Time, min)

Clear Well

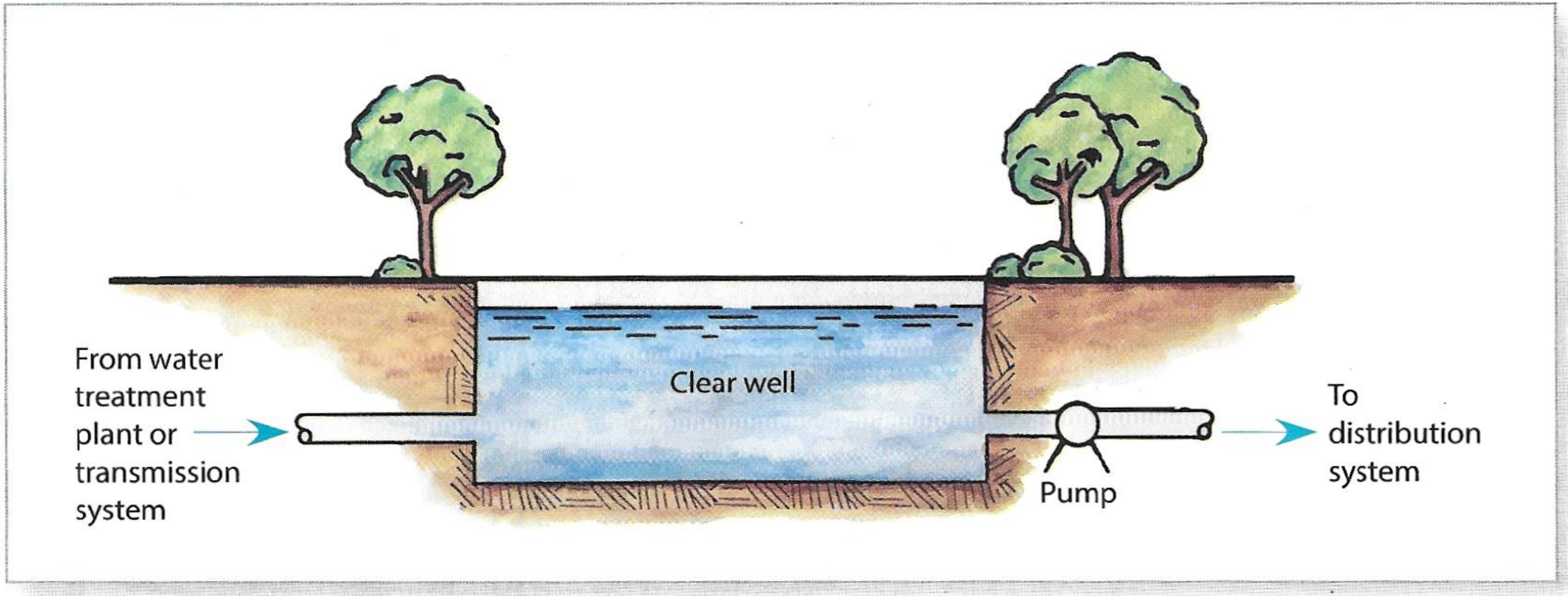
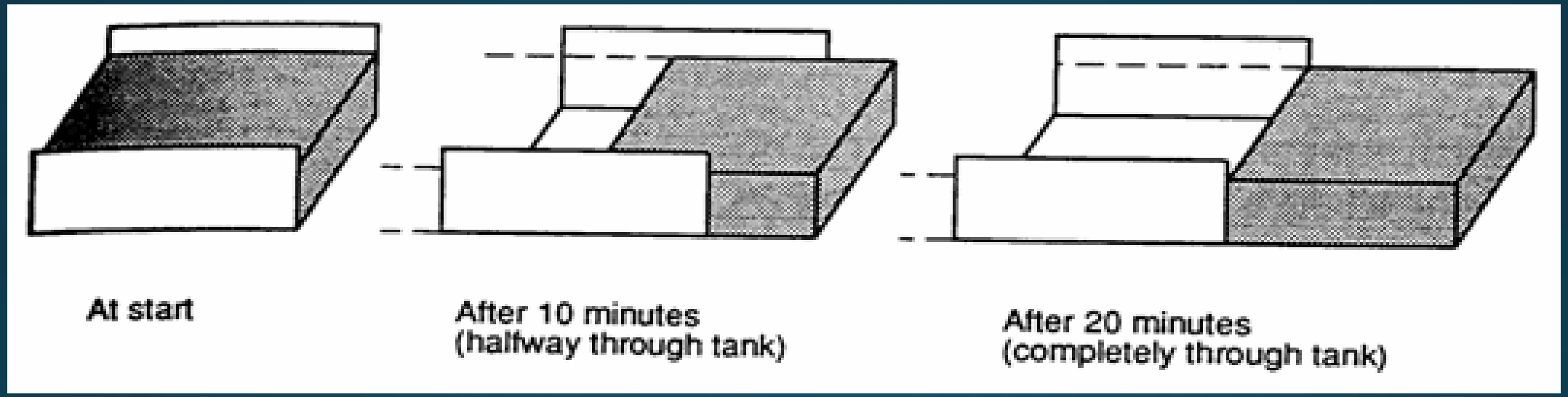


Figure 2.3 Clear well

Picture Courtesy of Sacramento State, Water Distribution System Operation and Maintenance, Seventh Ed. pg.40

Detention Time



$$\text{Detention Time} = \frac{\text{Volume}}{\text{Flow}} \qquad \frac{\text{Volume } ft^3}{\text{Flow } ft^3/sec} \qquad \frac{\text{Volume gal}}{\text{Flow gal/min}}$$

Detention Time and Clear Wells

Tank Materials: Steel

Welded Seam

Bolted Seam

Tank Materials : Pre-stressed Concrete

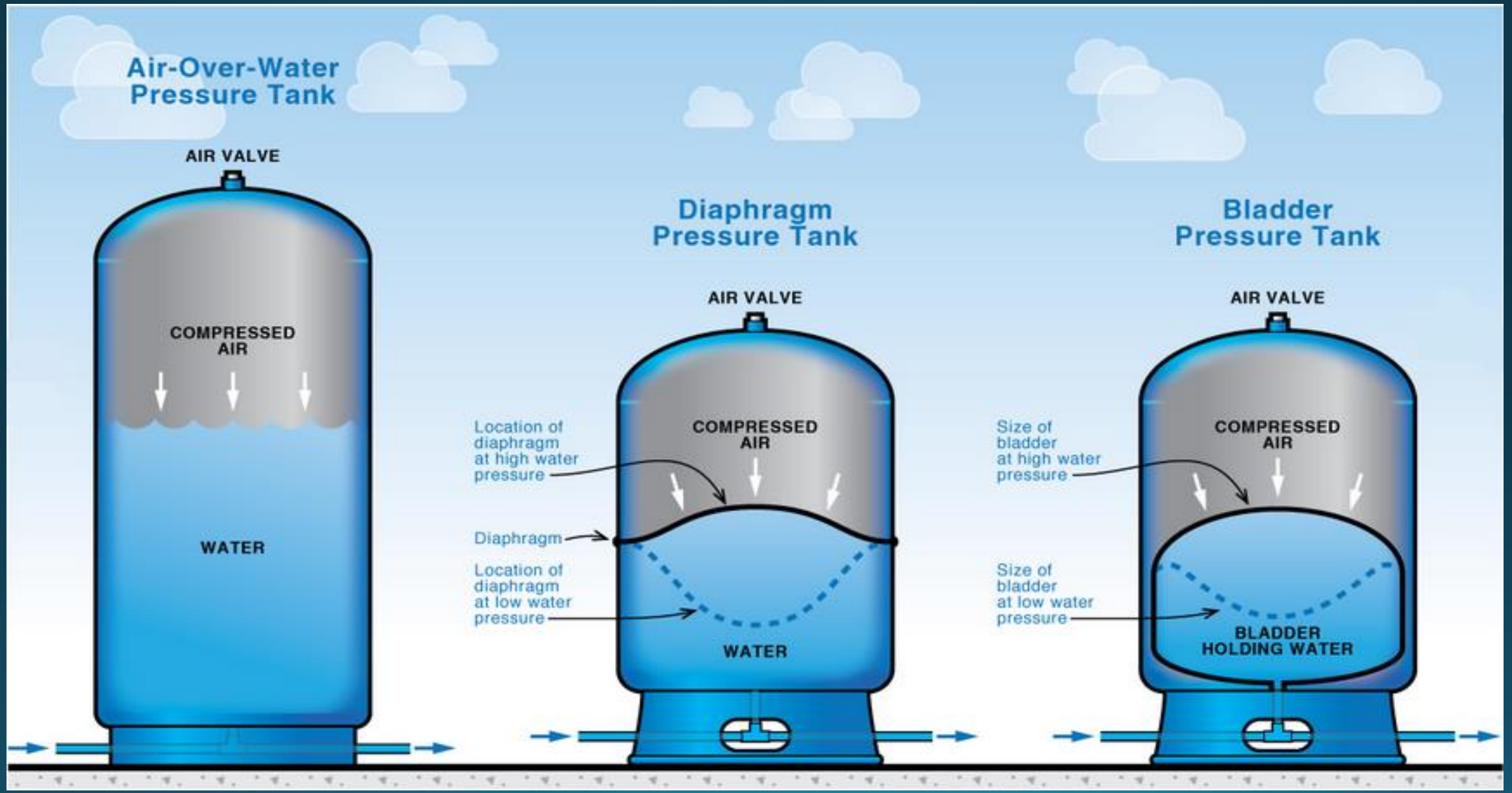
Nampa Prestressed Concrete 3 Million Gallon Water Reservoir

Project images by McAlvain Concrete, Inc.

Water Storage Reservoirs

- Glass Fused Steel Tanks
- Highly Corrosion Resistant
- Longer Life expectancy
- Initial Cost is Greater
- Vulnerable to Vandalism

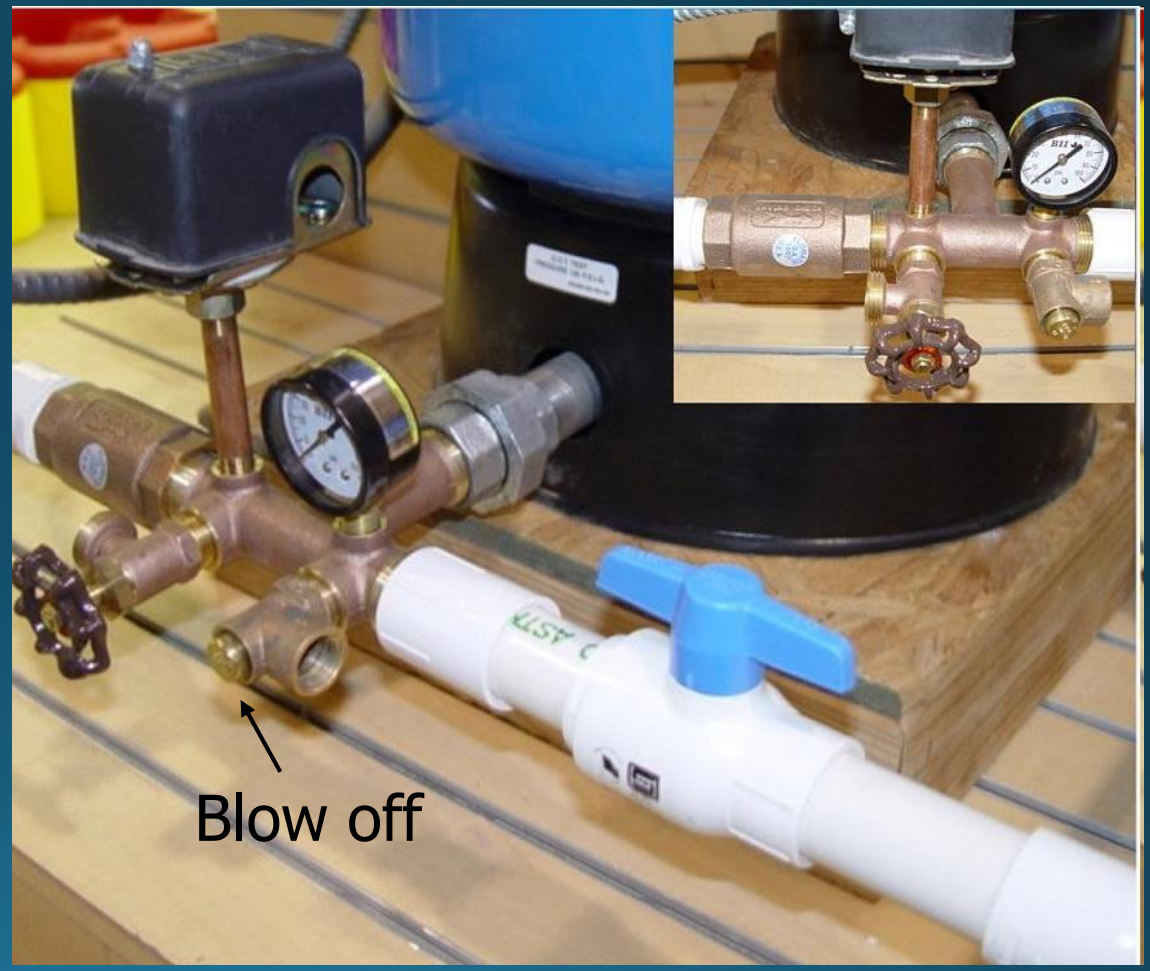
Pressure Tanks



Pressure Tanks

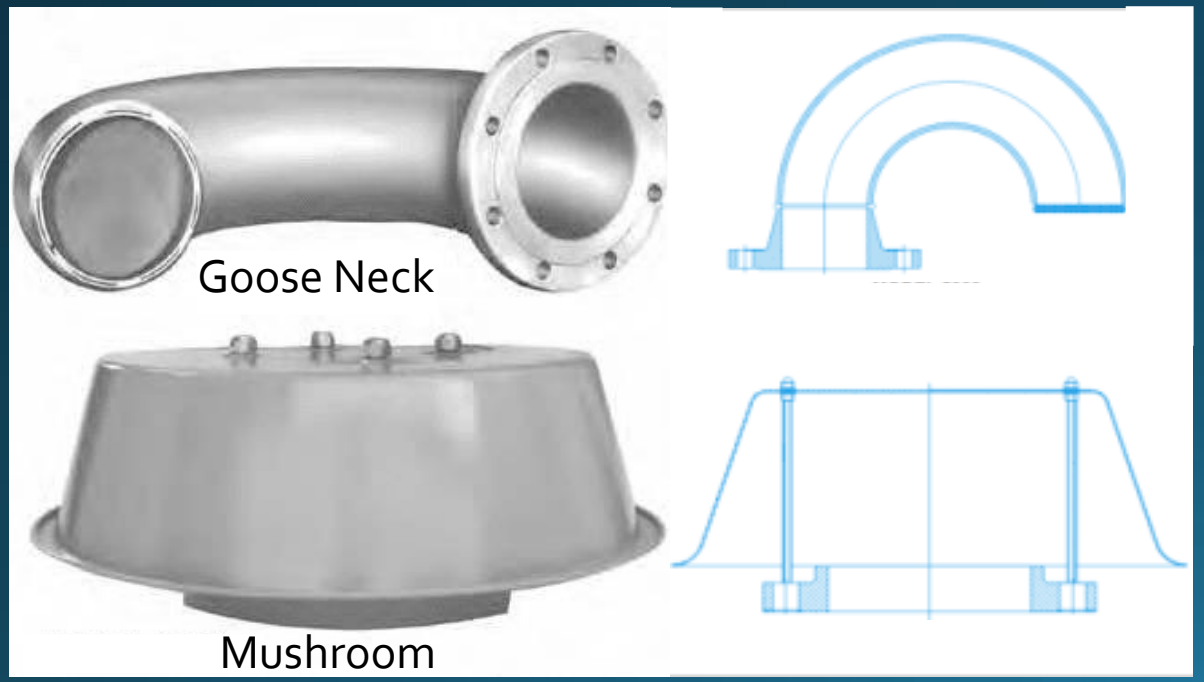
- Blow off valves should be able to discharge at pumping rate

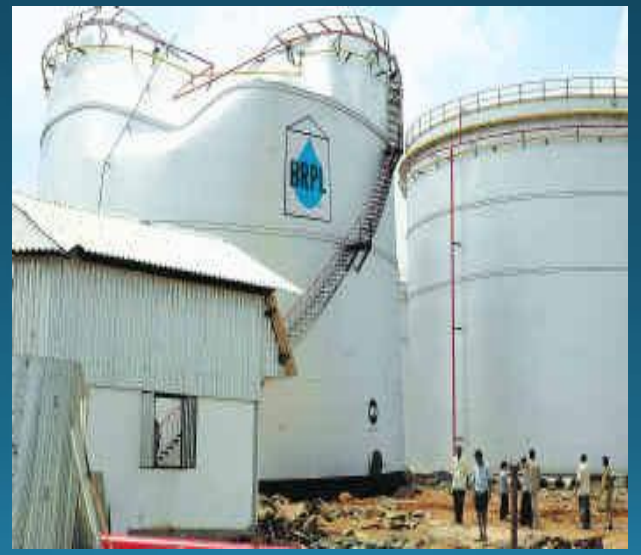
- Frequent on & off cycling of the booster pump shows lack of air in tank & is water logged



Tank Maintenance

- Inspect Vents- for ice, screen holes, animals, insects, etc.
- Clogged vents can cause vacuum.





Tank Maintenance: Corrosion

- Electrolysis decomposition of material by an outside electric current
- Galvanic corrosion caused by connecting dissimilar metals, no external current needed.
- Stress-corrosion cracking
  - Result of a high-pressure environment on the steel/metal forming tiny cracks
  - Fluctuating temperatures can also cause tiny cracks
- Caustic Agents
  - include any impure gas, liquid or solid that comes into contact with the metal. Hydrogen Sulfide and Sodium Hydroxide. Dirt!

Electrolysis

Decomposition of material by an outside electric current.

Electrolytic Corrosion Cell (4 parts)

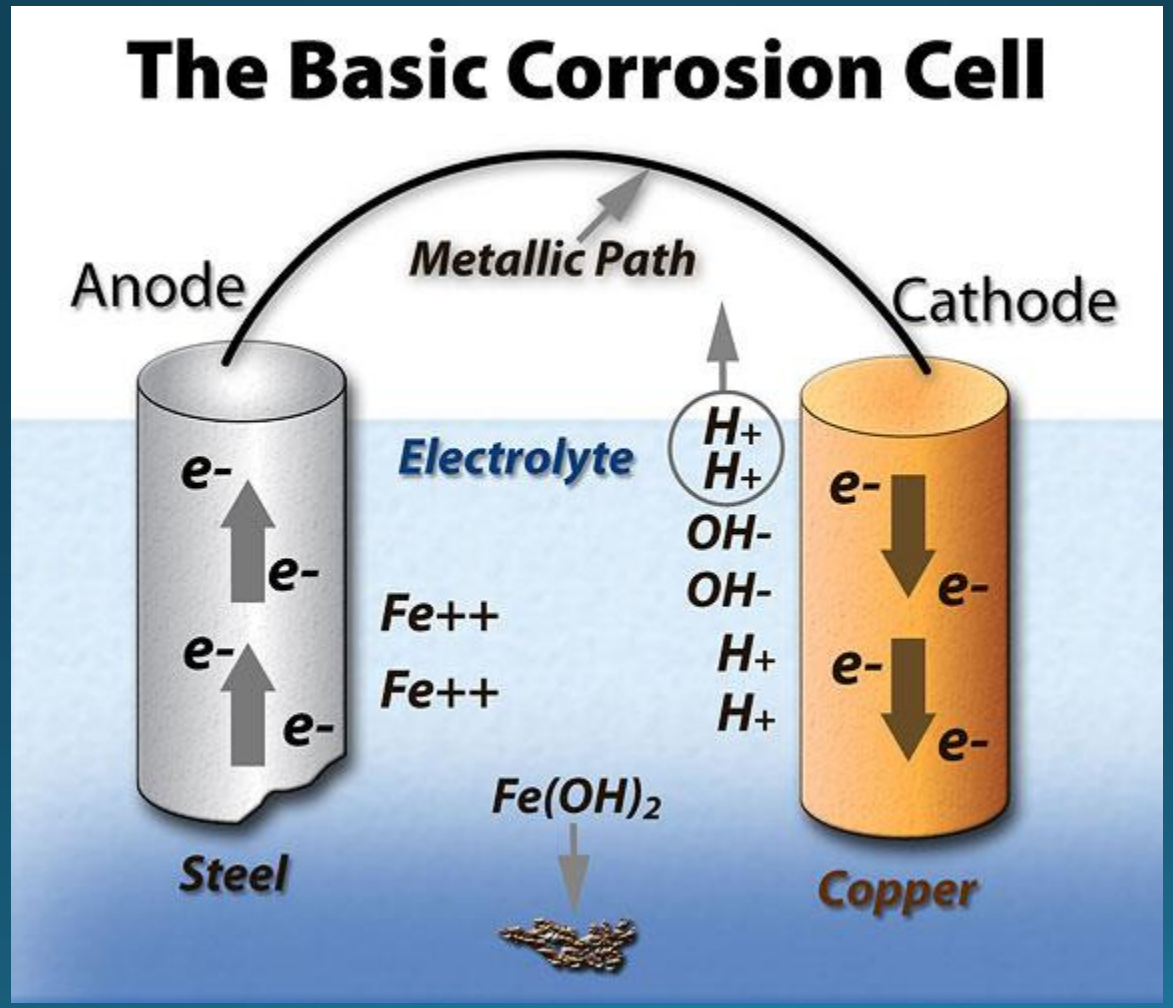
1. Anode – the anode is where corrosion occurs and is characterized by a lower electronegative potential than the cathode.

2. Cathode – the cathode is where current flows from the anode completing the corrosion reaction and is at a higher electro-potential than the anode.

3. Metallic path – the metallic path allows current to flow and completes the reaction circuit.

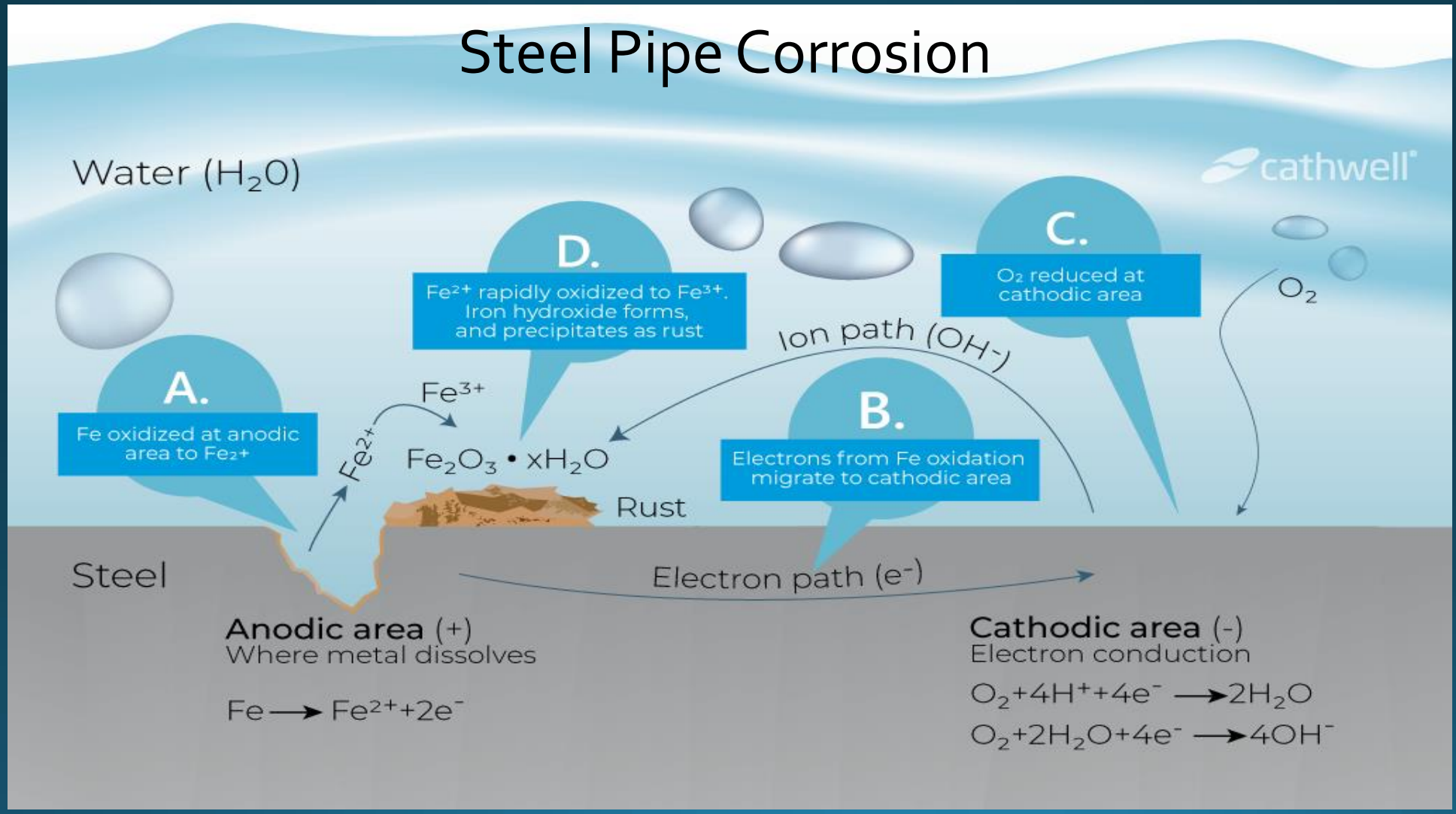
Electrolysis

4. Electrolyte – the electrolyte is a conductive environment that supplies the necessary reactants for corrosion to occur.



Electrolysis and Steel

Steel naturally reacts with water and oxygen releasing energy and returning to its more stable chemical state, iron oxide.

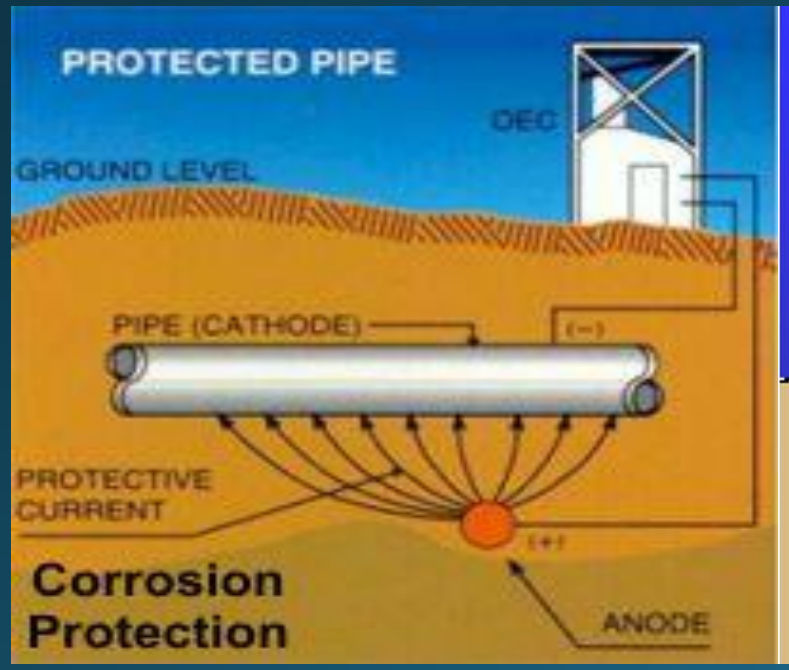


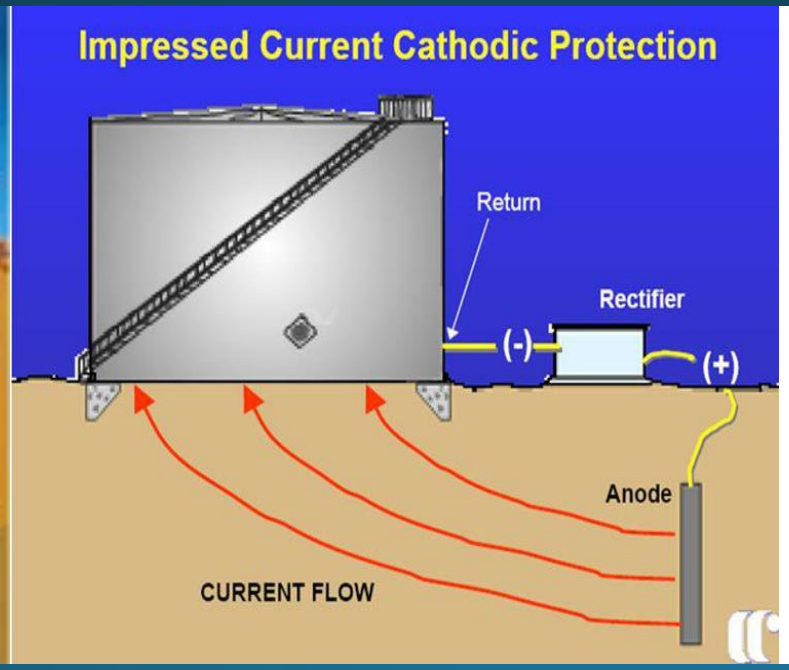
Electrolysis and Steel

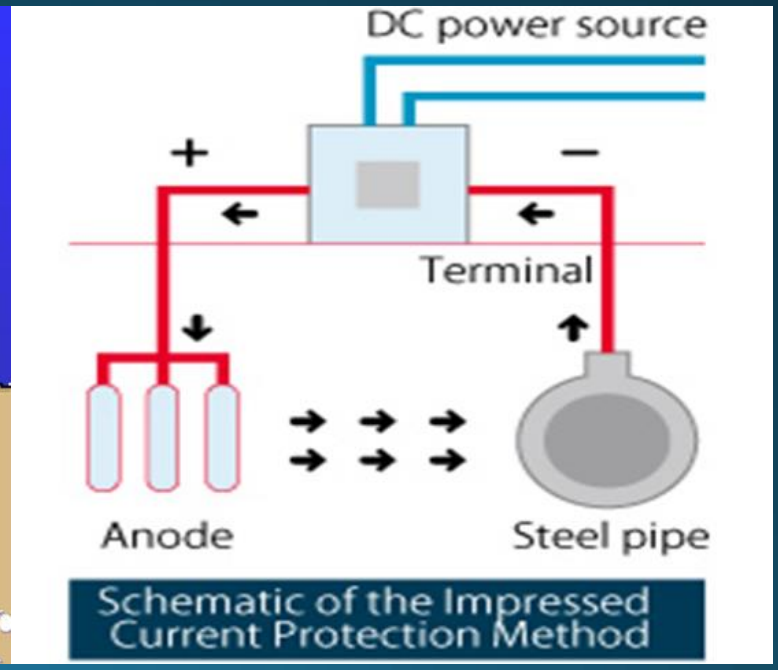
- Steel, at micro-level, is not entirely homogeneous
- Minor differences in electrical potential along the surface of a steel structure.
- Same piece of steel can provide both the anode and the cathode.
- Conductor of electricity, the adjacent cathodic and anodic steel regions have a metallic path.
- All that is needed is a suitable electrolyte – water, soil, even a thin film of condensation

Impressed Current (Active Protection)

- Prevent corrosion by applying a flow of electrical current from an external source (anode) through the environment and on to the metallic structure that is being protected







Passive Protection

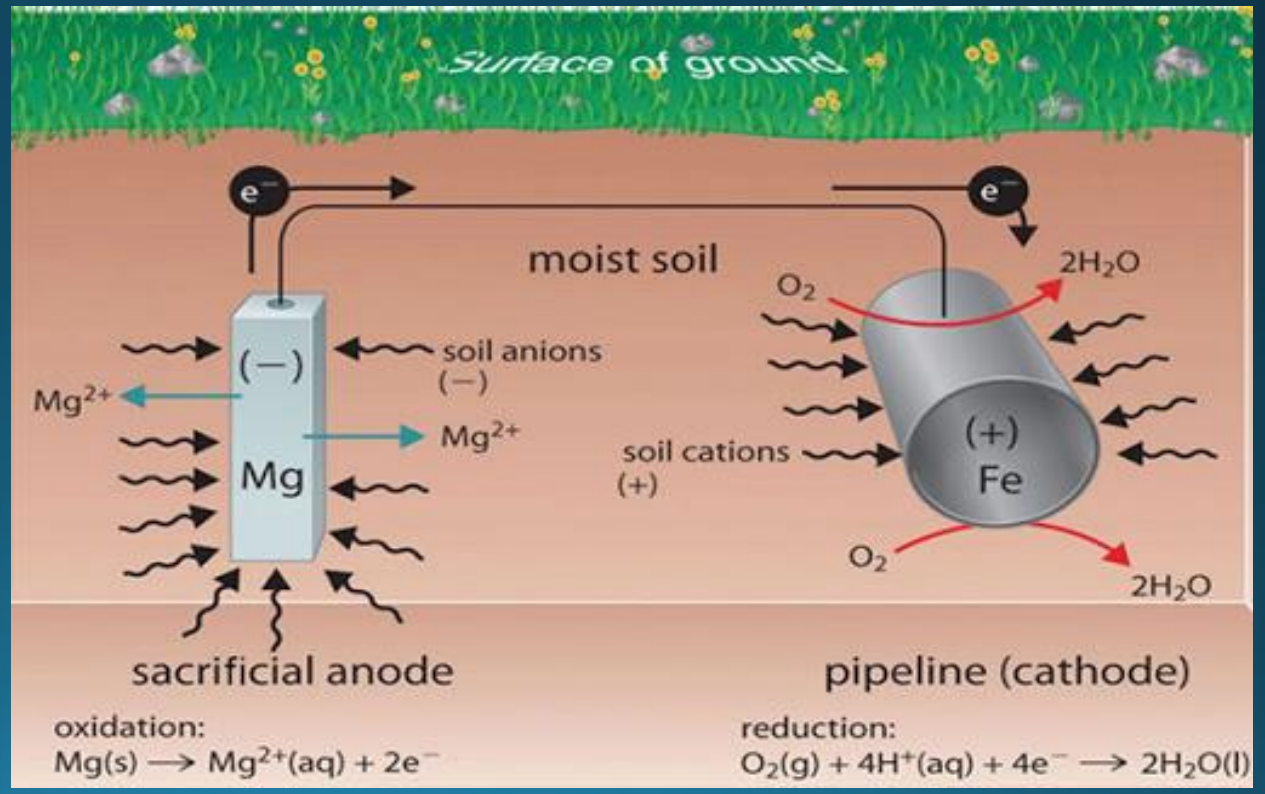
Anticorrosive coatings (Metal and Concrete)

- NSF-61 Approved
- Zinc-rich Moisture Cured Urethanes
- Fiberglass Reinforced Polymer
- Solvent Free Epoxy
- Ceramic Epoxy- 30mil thick with one application.

Passive Protection

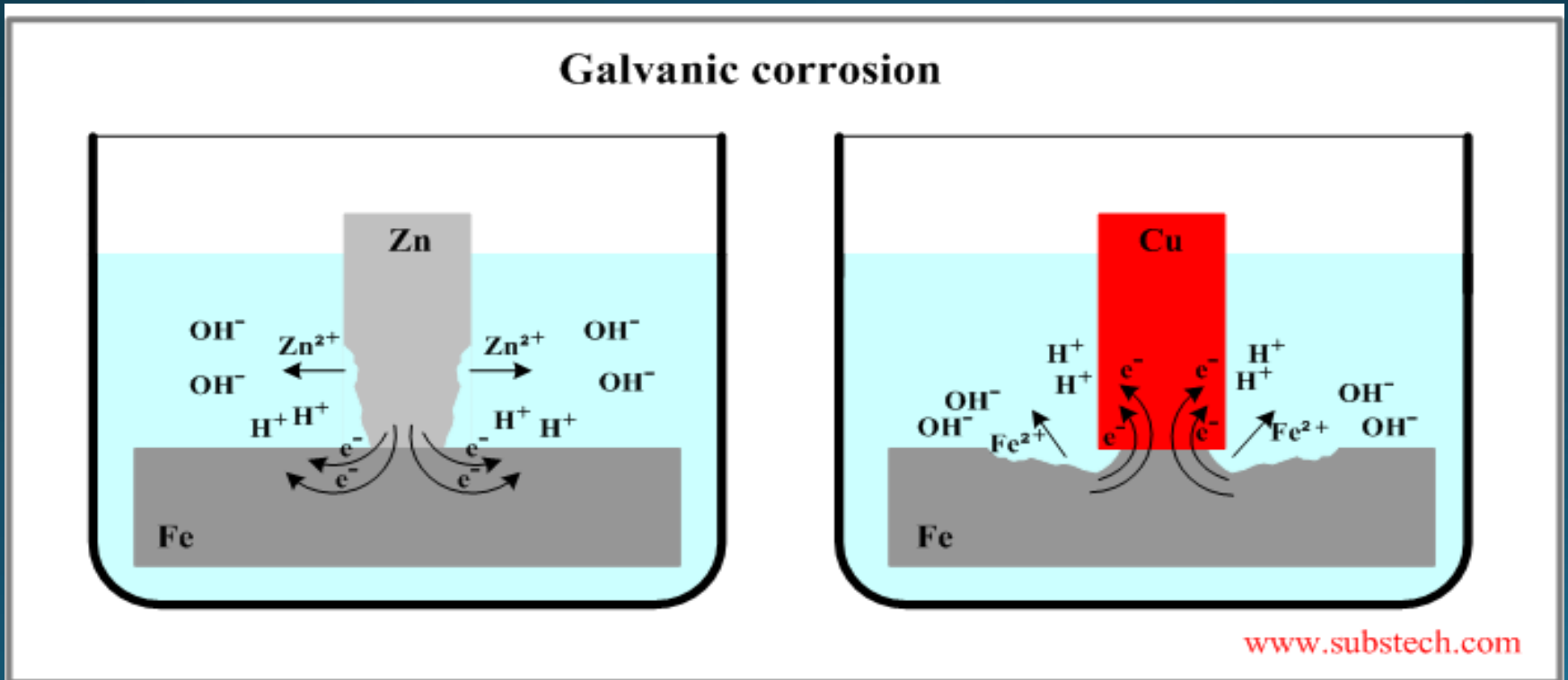
Cathodic protection

- Zinc or Magnesium Anodes attached to tank/pipes.
- Anode naturally corrodes preferentially to the tank or pipe.
- No external current needed.
- Forms Galvanic Cell



Galvanic Corrosion

- Spontaneous electrochemical reaction.
- Does not require external voltage source.
- One metal corrodes preferentially to another
- In the presence of an electrolyte.



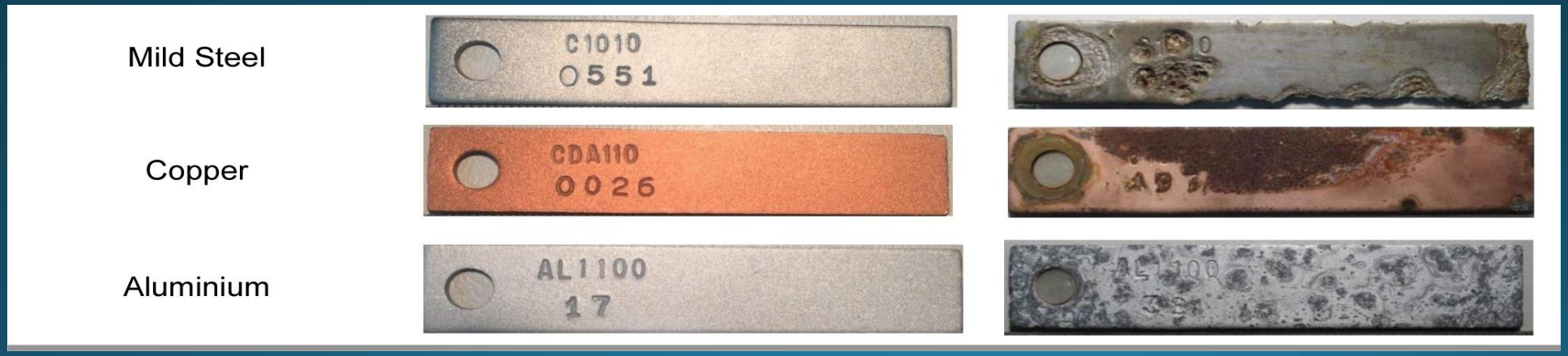
Galvanic Corrosion

	Mag.	Alum.	Zinc	Iron	Cad.	Nick.	Tin	Lead	Copper	Silver	Pall.	Gold
Magnesium	0.00	-0.71	-1.61	-1.93	-1.97	-2.12	-2.23	-2.24	-2.71	-3.17	-3.36	-3.87
Aluminum	0.71	0.00	-0.90	-1.22	-1.26	-1.41	-1.52	-1.53	-2.00	-2.46	-2.65	-3.16
Zinc	1.61	0.90	0.00	-0.32	-0.36	-0.51	-0.63	-0.64	-1.10	-1.56	-1.75	-2.26
Iron	1.93	1.22	0.32	0.00	-0.04	-0.19	-0.30	-0.31	-0.78	-1.24	-1.43	-1.94
Cadmium	1.97	1.26	0.36	0.04	0.00	-0.15	-0.27	-0.28	-0.74	-1.20	-1.39	-1.90
Nickel	2.12	1.41	0.51	0.19	0.15	0.00	-0.11	-0.12	-0.59	-1.05	-1.24	-1.75
Tin	2.23	1.52	0.63	0.30	0.27	0.11	0.00	-0.01	-0.47	-0.94	-1.12	-1.64
Lead	2.24	1.53	0.64	0.31	0.28	0.12	0.01	0.00	-0.46	-0.93	-1.11	-1.63
Copper	2.71	2.00	1.10	0.78	0.74	0.59	0.40	0.46	0.00	-0.46	-0.65	-1.16
Silver	3.17	2.46	1.56	1.24	1.20	1.05	0.94	0.93	0.46	0.00	-0.19	-0.70
Palladium	3.36	2.65	1.75	1.43	1.39	1.24	1.12	1.11	0.65	0.19	0.00	-0.51
Gold	3.87	3.16	2.26	1.94	1.90	1.75	1.64	1.63	1.16	0.70	0.51	0.00

Green: Low Galvanic Potential
Yellow: Less Than Optimal But Ok
White: High Galvanic Potential

Metal Coupon

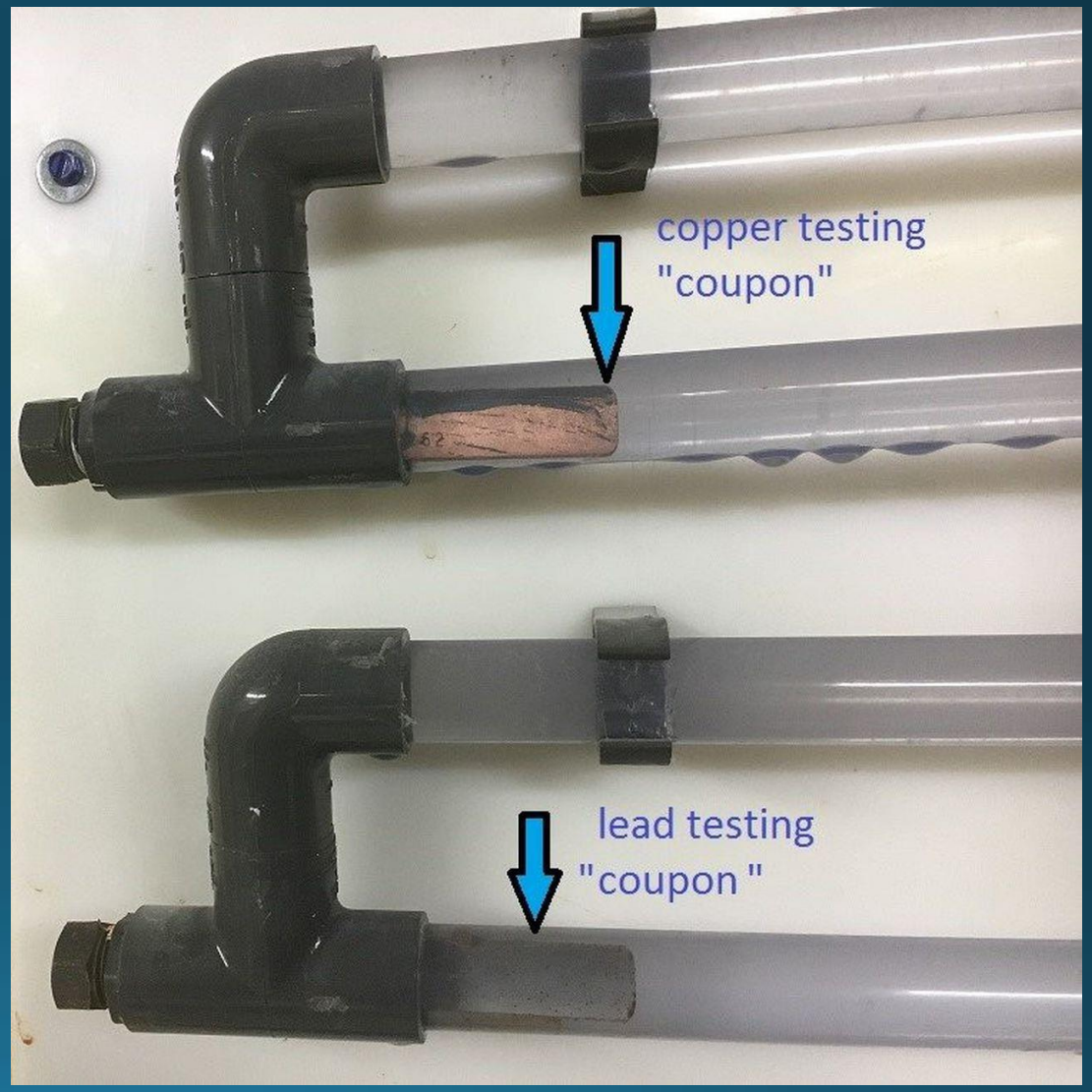
- Sacrificial Metal Alloys
- Cleaned, pre-weighed, known surface area.
- Commonly used coupons:
  - ½ inch wide
  - 3 inch long
  - 1/16 inch thick
  - ~3.4 in^2 surface area



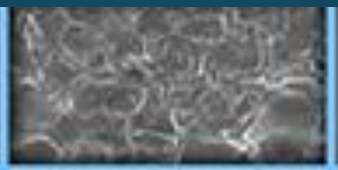
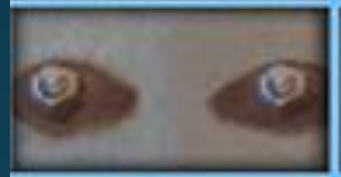
Metal Coupon

- Placed in water to determine rate of corrosion.

- Removed at selected time intervals
  - cleaned and reweighed to determine the metal loss.



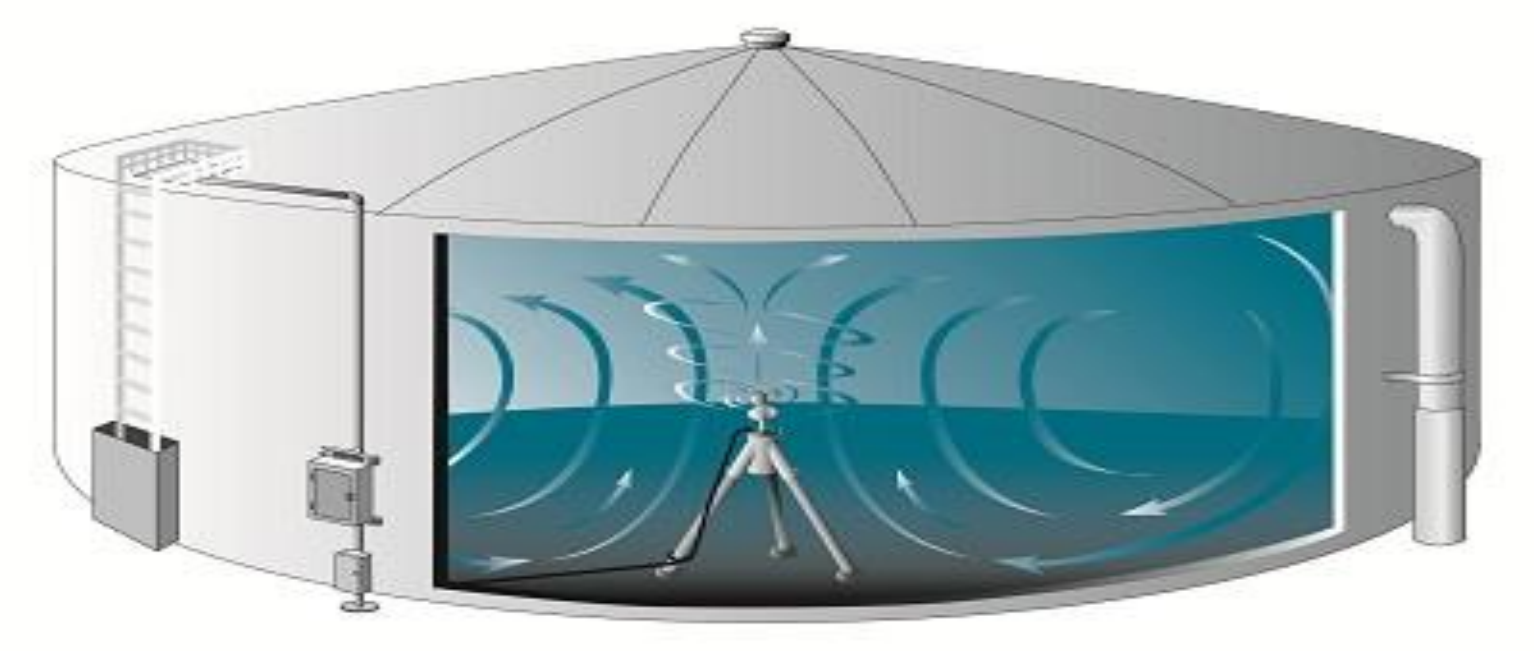
Common Forms of Corrosion

	Uniform (general)		Intergranular
	Pitting		Selective Leaching/Dealloying
	Crevice		Stress Corrosion Cracking
	Galvanic		Solar Ultraviolet degradation
	Erosion Corrosion		Other less common types and combinations

Tank Maintenance

Cycling of water (movement) to prevent freezing or

Water quality problems: Increased age of the water from low demand or short circuiting



Tank Maintenance

Tank inspections and interior cleaning every 3 to 5 years

Drain and spray tank or divers clean while full.

Repair, Disinfect, Bac T Samples

Disinfection of Reservoirs

Facility disinfected before it is put on line reduces positive bacteria tests by 85%

AWWA C652

- Full reservoir – 10 ppm after 24 hours
- Spraying interior – 200 ppm – 30 minute detention time
- Fill 5 % to 50 ppm –sit 6 hours, then fill rest of tank
- >2 ppm after 24 hours

2 Total Coliform Samples, now and 24hr after

Confined Spaces

Tanks, Vaults, Chemical Storage Sites

Vehicles- Keep away from manhole

CO_2 and CO heavier than air

Minimum oxygen level of 19.5%

Minimum 3 people present.

Distribution System and Pipes

Distribution Pipes

- Steel
- Ductile Iron
- Concrete
- PVC
- HDPE

Distribution Pipes

- Steel Pipes

https://www.youtube.com/watch?v=cfxJp4F5dxs&list=PL9NfaH39Z9FJlWTHBhHo-xIqwfxRjEscS&index=22

- Ductile Iron

https://www.youtube.com/watch?v=KPggP4LAgXw&index=14&list=PL9NfaH39Z9FJlWTHBhHo-xIqwfxRjEscS

- Concrete

https://www.youtube.com/watch?v=kSim5UAzG-w&list=PL9NfaH39Z9FJlWTHBhHo-xIqwfxRjEscS&index=24

- PVC

https://www.youtube.com/watch?v=KumLHPhAsEQ&list=PL9NfaH39Z9FJlWTHBhHo-xIqwfxRjEscS&index=11

- HDPE

https://www.youtube.com/watch?v=NWWvTsImsdU&index=10&list=PL9NfaH39Z9FJlWTHBhHo-xIqwfxRjEscS

Distribution Pipes

C-Factor- Smoothness of the interior of the pipe.

Higher C-Factor = more smooth

To calc measure Flow (gpm), pipe diameter, distance between two pressure gauges, and the energy loss between the two gauges.

Hazen Williams Coefficient, C

Pipe Material	Design C
PVC	150
Asbestos Cement	140
Welded Steel	100
Concrete	100
Cast Iron	100
Copper or Brass	130
Vitrified Clay	100
Corrugated Steel	60

Distribution Pipes

Pressures measured at a fire hydrant or pressure regulating station

Minimum Water main size:

8 inch with fire hydrants (Why?)

*Unless you have an engineer signature

4 inch without fire hydrants

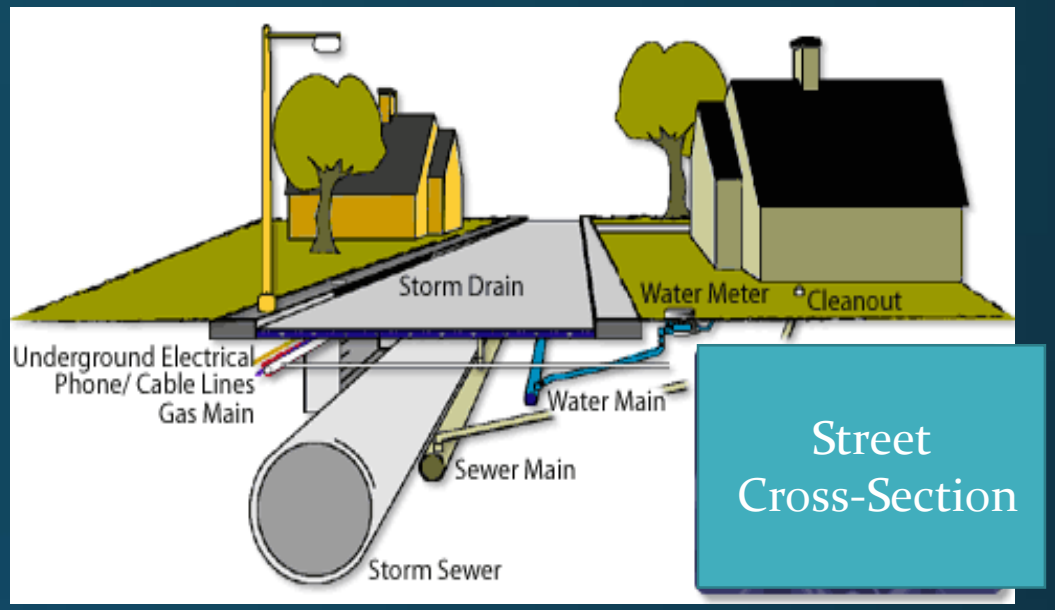
Distribution Systems

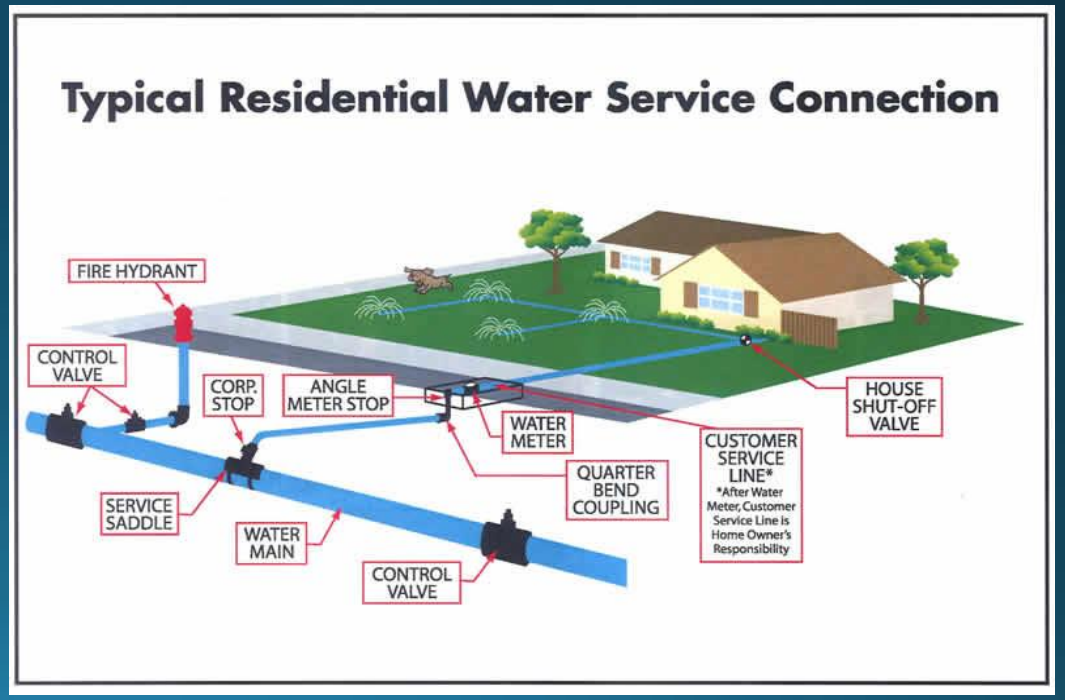
Water mains 10 Feet horizontal distance from sewer main

Water main and sewer mains must cross at least 18" of separation

Water line is on top - minimum 12" of separation in parallel Installations

Water & sewer not installed in the same trench.





Customer Service Connection

Curb stop valve for customer service line shut off at the meter.

¾” most common residential connection.

Corp Stop shut off at the main line.

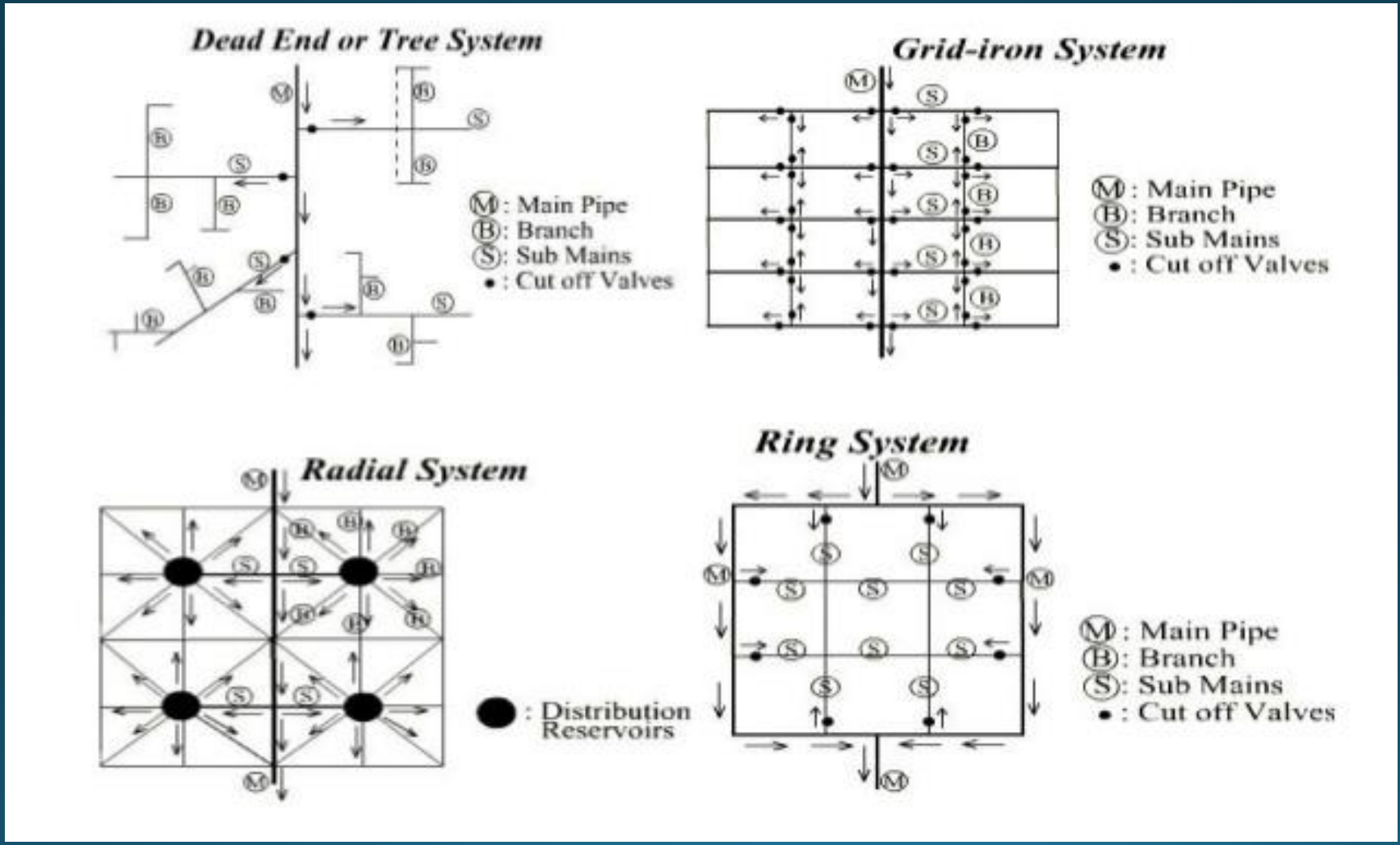
Thaw service line with hot water or warm air

Consider flow rate & pressure for sizing

Distribution Systems

- **Hydraulic adequacy** aka **Hydraulic Modeling**: determined by pressure and flow measurements throughout system at various times to Identify Fire Flows in every section of Distribution System
- Looped to prevent dead ends, quality problems, and better flow
- Anaerobic growth develops in water devoid of oxygen causing odor problems

Distribution System Layout

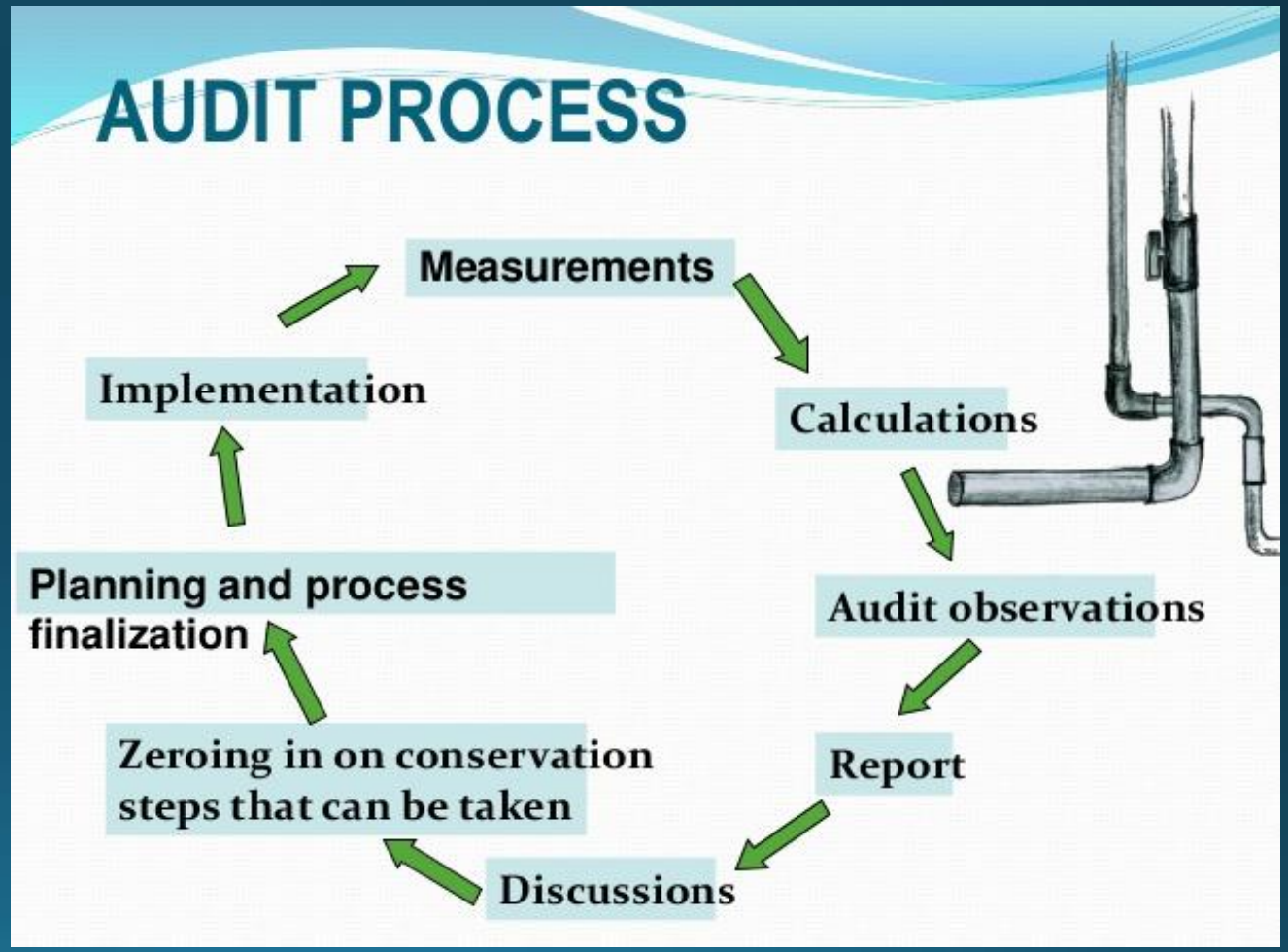


Water Distribution Systems

Leaks get worse!!!

Do a water audit to identify water & revenue losses

Leak surveys should be done during low flows



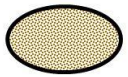
Water Main Installation

Trench Safety

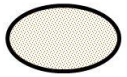
SOIL CLASSIFICATION SYSTEM

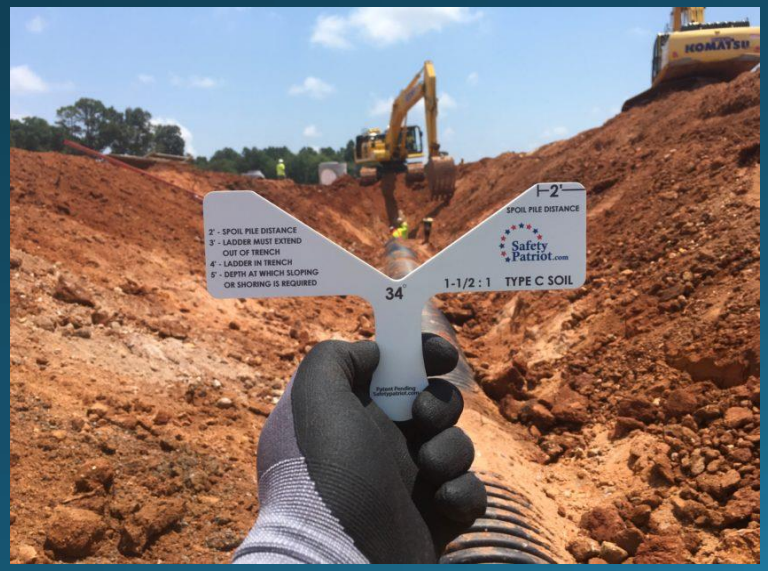
☑ **TYPE A SOILS**
- Clay
- Silty Clay
- Sandy Clay
- Clay Loam

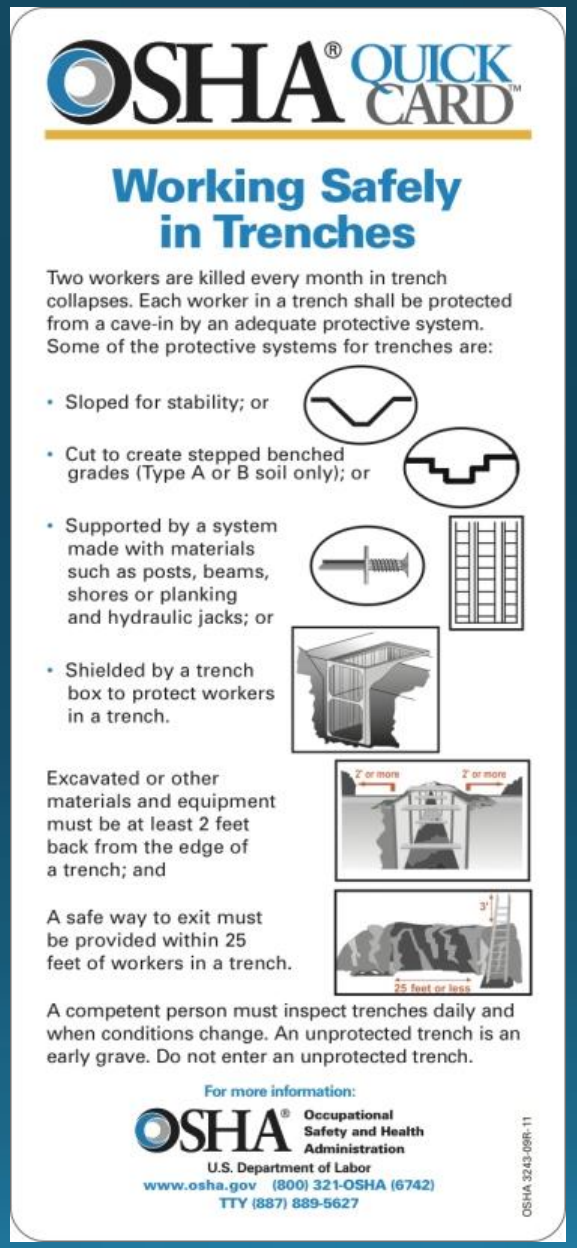
☑ **TYPE B SOILS**
- Granular Cohesionless Soils (Silt Loam)



☑ **TYPE C SOILS**
- Gravel
- Sand
- Loamy Sand







OSHA® QUICK CARD™

Working Safely in Trenches

Two workers are killed every month in trench collapses. Each worker in a trench shall be protected from a cave-in by an adequate protective system. Some of the protective systems for trenches are:

- Sloped for stability; or
- Cut to create stepped benched grades (Type A or B soil only); or
- Supported by a system made with materials such as posts, beams, shores or planking and hydraulic jacks; or
- Shielded by a trench box to protect workers in a trench.

Excavated or other materials and equipment must be at least 2 feet back from the edge of a trench; and

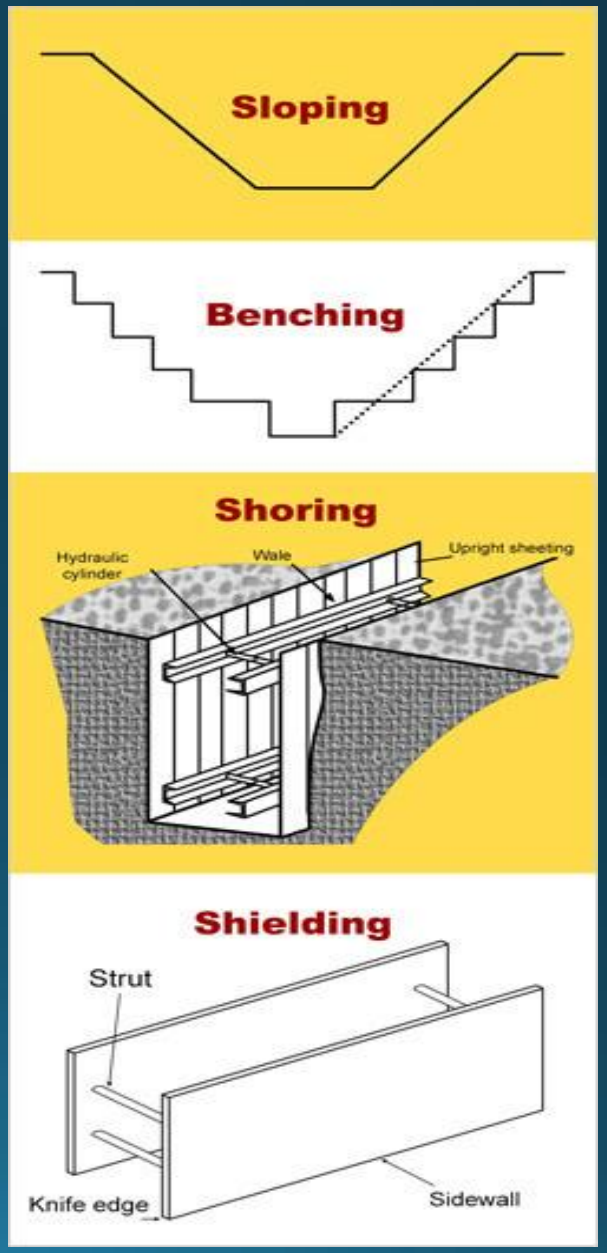
A safe way to exit must be provided within 25 feet of workers in a trench.

A competent person must inspect trenches daily and when conditions change. An unprotected trench is an early grave. Do not enter an unprotected trench.

For more information:

OSHA® Occupational Safety and Health Administration
U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)
TTY (887) 889-5627

OSHA 3243-09R-11



Water Main Installation

Jacking and Boring

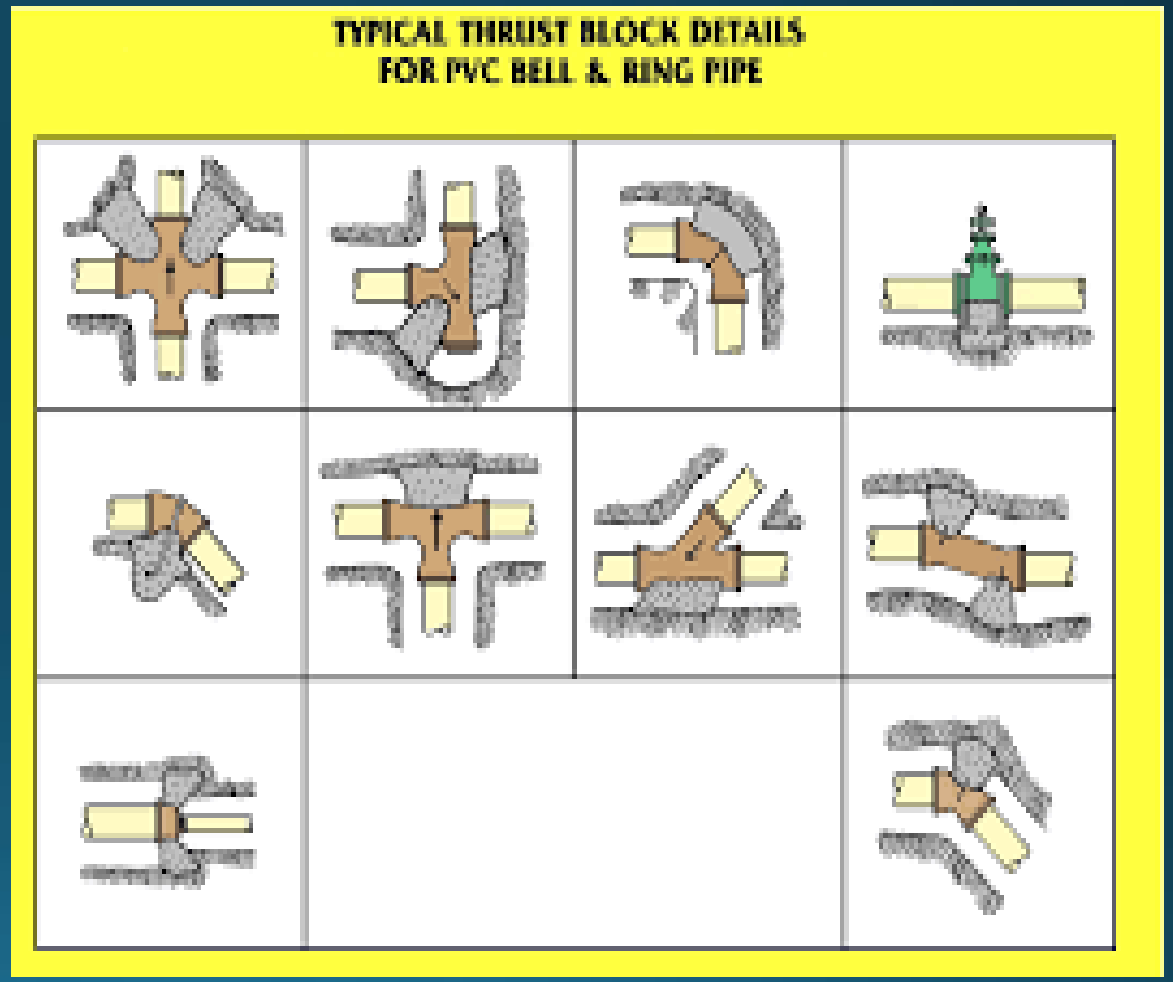
The most common technique for the construction of a pipeline under a heavily traveled highway or railway without disrupting the traffic

What is Wrong Here?

Thrust Blocking

- **Thrust Block** - a concrete mass cast in place between a fitting and the **undisturbed soil** at the side or bottom of the pipe trench

- Purpose is to keep fittings from moving & either coming loose or apart from the force of the water pressure in the pipe.
- Block should be **centered on thrust force**



Thrust Blocking - Mechanical Fittings

Restrained fitting – use of clamps or anchor screws on fittings

Tie rods – used on mechanical joint fittings that a located close together

Thrust Blocks

Should be place behind the foot of the hydrant at the flow line.

Should not cover the drain hole on dry barrel type.

Pressure Testing New Water Main

Should be done at 50% higher than normal operating pressure or 150 psi whichever is larger

Duration 4 Hours

Line Collapse @ Folsom

Caused by not opening an upstream valve before they began moving water downstream.

A vacuum developed before they realized what happened and the pipe pancaked.

The pipe is the main transmission line to supply water for the City of Folsom.

Water Mains Installation

Precautionary steps taken to put into service:

Keep pipe clean

Keep ends of pipe plugged when storing

Flush out debris

Pressure and leak test

Disinfect the pipe per AWWA C651

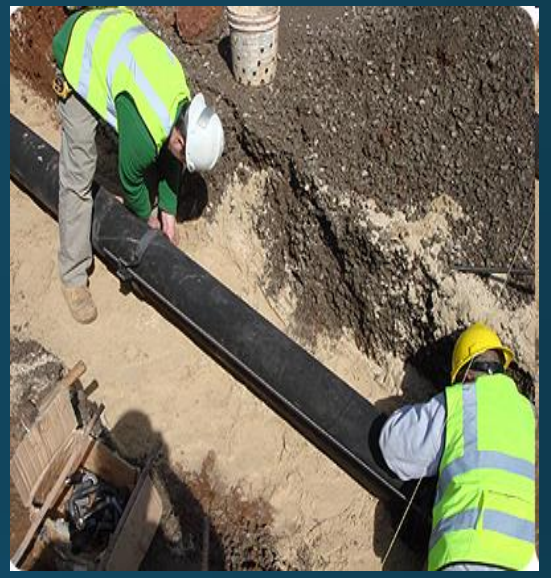
Repair, Disinfect, Total Coliform Samples

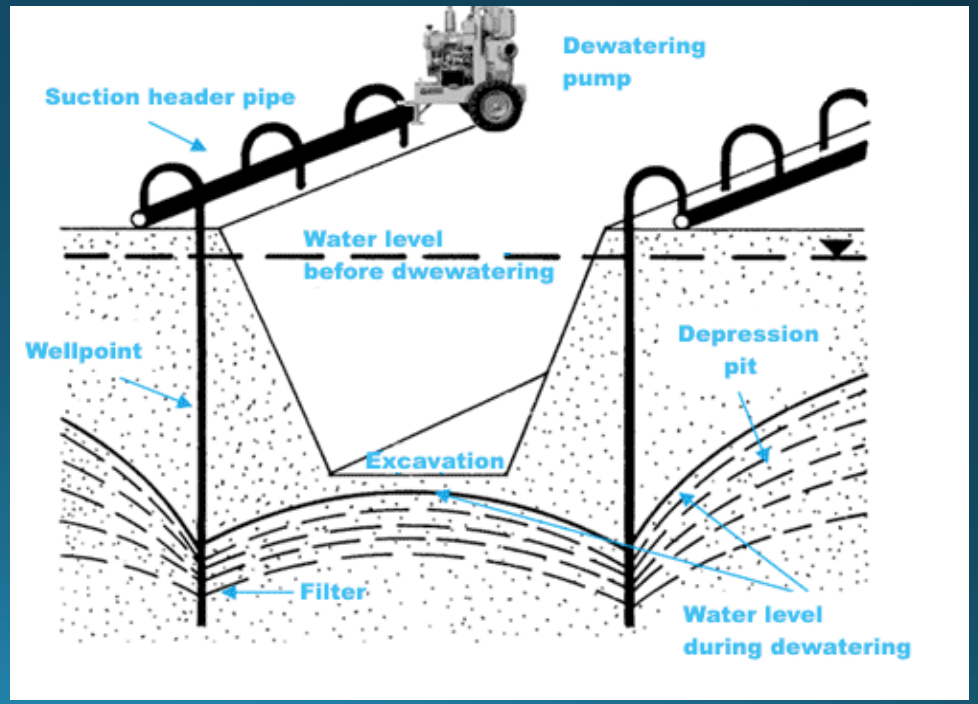
Backfilling Mains

Soil placed equally on both sides half way up of the pipe in layers hand tamped

Pipe covered by about 12" of soil before charging

"Well Point" used to dewater trenches





Water Mains

AWWA C651

Disinfect with tablets or granular -25 ppm after 24 hours

Continuous Feed – 10 ppm after 24 hours

- Fill main with water
- Flush out debris
- Fill with chlorinated water

Flush highly chlorinated water through dechlorinating chemical.

Bacteriological Samples –

- 2 samples taken 24 hours apart.

Fire Hydrants

WSO Water Distribution Grades 1 & 2: Hydrant Types, Ch. 10

https://www.youtube.com/watch?v=lIEruocRhOw&index=7&list=PL9NfaH39Z9FJlWTHBhHo-xIqwfxRjEscS

Fire Hydrants

Hydrant bury is the distance below the ground to the main connection.

Flow tests should be performed periodically & after major changes to distribution system

Stringing is dropping a weighted string down the barrel of hydrant to check for water

Nozzles are usually 2.5 and 4.5 inches

Hydrant Cap Color Codes

Class	Color	Water Flow (GPM)
AA	Light blue/White	1500 or more
A	Green	1000–1499
B	Orange	500–999
C	Red	Less than 500

Fire Hydrants

Flushing hydrants can stir up silt creating water quality problems

Should be tested for flow with a pitot gauge

Flow tests show quantity of available water

Fire Hydrants

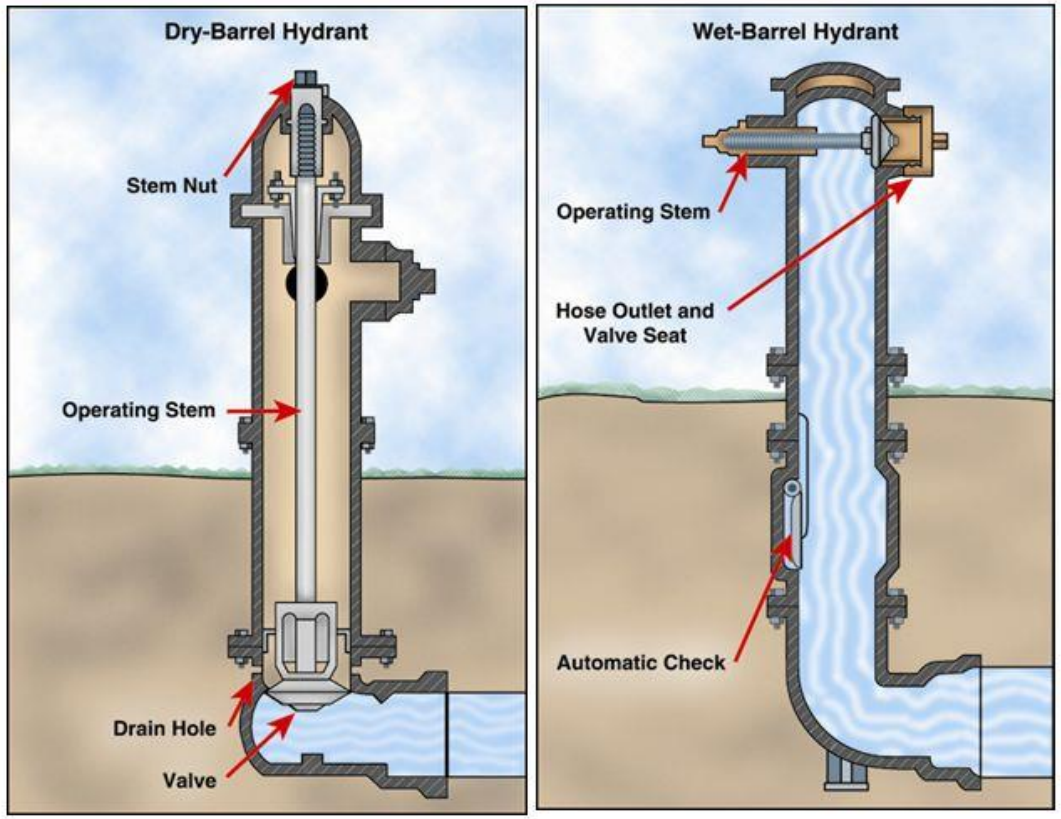
Fire fighters can create negative pressures

Dead end systems would likely have inadequate flows for firemen

Fire Hydrants

Dry- and wet-barrel hydrants are designed for different climates.

- Designed for use in climates that have freezing temps



- Usually installed in warmer climates where prolonged periods of subfreezing weather are uncommon

IFSTA
INTERNATIONAL FIRE SERVICE TRAINING ASSOCIATION

Dry Barrel Hydrants

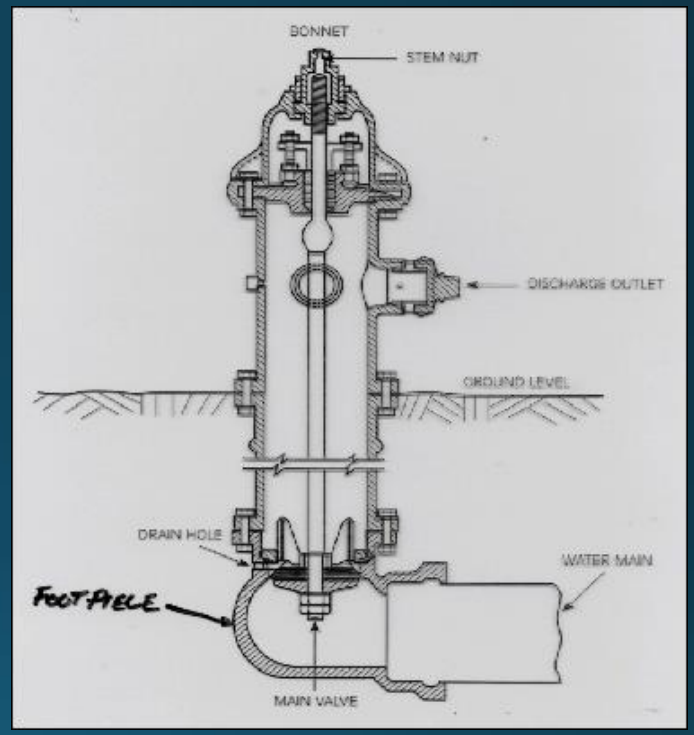
Operating valve located in the base of the hydrant

Drain hole drains barrel to protect from freezing

Partially open valve would cause excessive leakage from drain hole

Must be tested for leakage with main valve open & caps on

Use a listening device to check for leaking valve seat



Flush Hydrants

Means hydrant is flush with a wall or ground

For areas where post hydrants are not suitable

Flushing Procedure

- Notify customers thru billing, newspaper, or electronic media of times and places affected or anything affecting the condition of their water
- Explain Intent Of Flushing
- Notify Hospitals, Dialysis Patients, Restaurants, Laundromats, & Others That May Be Affected

Flushing The System

When The System Has Become Contaminated

Newly Installed Or Repaired Mainlines

Poor water quality complaints.

Flushing Hydrants

Helps remove taste & odor causing deposits

Helps remove encrustations that may restrict flow

Helps remove sand, rust, & biological materials that cause water quality problems

FLUSHING PROCEDURE

Try To Avoid Flooding Traffic Areas

Open Hydrant Fully For 5 To 10 Minutes To Stir Up Deposits (If you have capacity)

Don't let nearby areas drop below 20 psi to avoid negative pressures

Record Pertinent Data: Odor, Water Appearance, Times, & Places, Etc.

Flushing

Flush at a velocity 2.5 fps or greater

Required gpm flow for velocity

4" pipe	100 gpm
6" pipe	200 gpm
8" pipe	400 gpm
10" pipe	600 gpm
12" pipe	900 gpm

Flushing the System

Dead End Systems

Water Quality Issues

Customer Complaints

Be mindful of environmental concerns

During periods of low demand

CHLORINE NEUTRALIZING CHEMICALS

SULFUR DIOXIDE

SODIUM BISULFITE

SODIUM SULFITE

SODIUM THIOSULFATE

ASCORBIC ACID (Vitamin C)

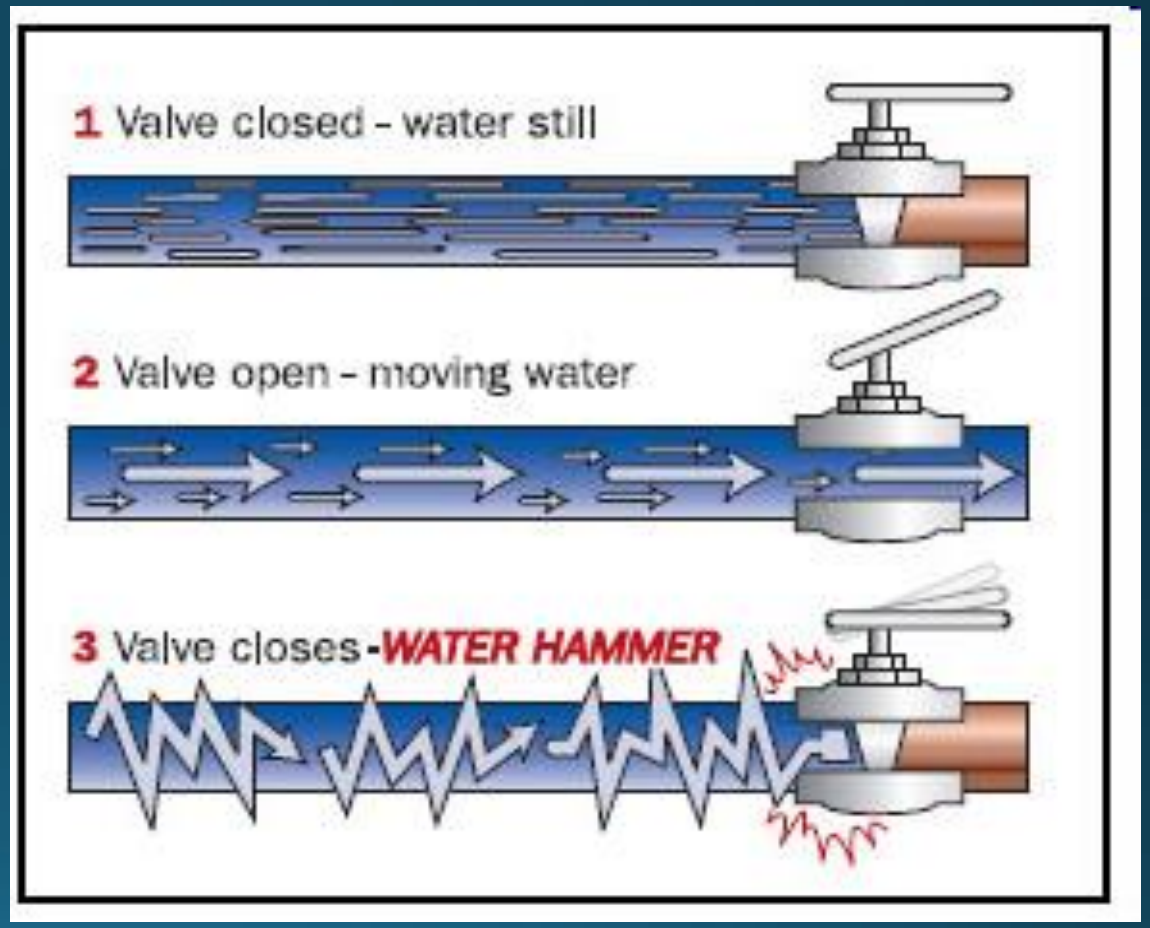
What's wrong with this picture?

Water Hammer

Occurs when a valve is closed quickly or pump shuts down and causes the water pressures to rise and fall rapidly.

Sounds like some hammering on pipe.

Can damage pipes, causing them burst.



Pounds of H_2O per Foot of Pipe

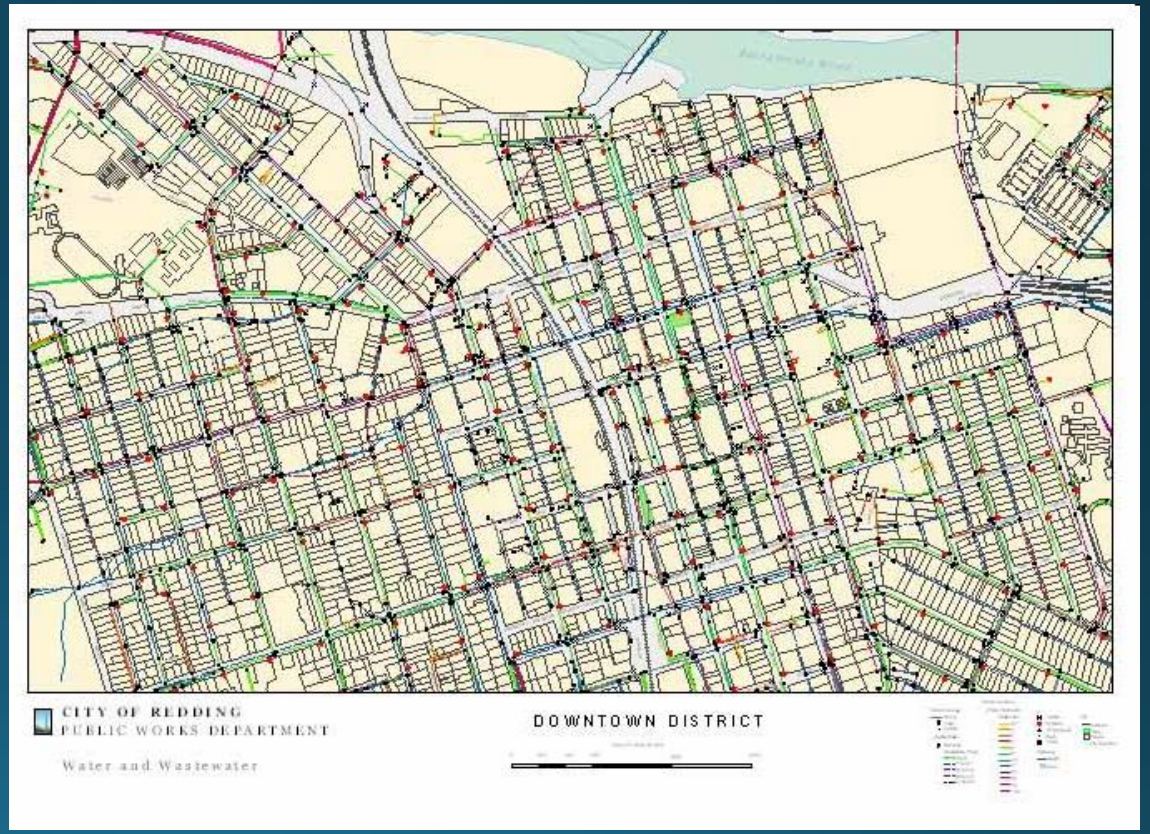
Pounds per Gallon

1 gallon water = 8.34 lbs

Inches	Conv to Feet	Vol ft^3	Gallons/ft	Lbs/ft
4	0.33	0.09	0.65	5.44
6	0.50	0.20	1.47	12.24
8	0.67	0.35	2.61	21.76
10	0.83	0.55	4.08	34.01
12	1.00	0.79	5.87	48.97
14	1.17	1.07	7.99	66.65
16	1.33	1.40	10.44	87.06
18	1.50	1.77	13.21	110.18
20	1.67	2.18	16.31	136.03
22	1.83	2.64	19.74	164.60
24	2.00	3.14	23.49	195.88
28	2.33	4.27	31.97	266.62
30	2.50	4.91	36.70	306.07
32	2.67	5.58	41.76	348.24
34	2.83	6.30	47.14	393.13
36	3.00	7.07	52.85	440.74

System Mapping

Accurate mapping ensures the operators can locate the valves and main lines in case of a main break or leak to isolate the effected area.



Thank You for Attending!

NEVADA
RURAL WATER ASSOCIATION